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ABSTRACT

The purpose of this two-year research project at Illinois State University was to develop a concise training program designed to enhance the ability of teachers to facilitate problem-solving behaviors on the part of elementary and secondary school pupils, with particular emphasis on creative hypothesizing. Specifically, the program was designed to alert teachers to the importance of instruction for creative problem solving, provide them with a sound rationale, and equip them with a repertoire of appropriate teaching strategies and skills. A concise instructional sequence was developed by means of a sequential training instruction feedback revision cycle. Teacher Education students in a junior year participation program were the experimental subjects. It involved direct presentation of content, demonstration of process, analysis of progress, modeling, and micro-teaching. It dealt with establishing classroom climate, thinking activities based on the Structure-of-Intellect model, brainstorming, attending to the problem, examining the problem from various vantage points, and included techniques for peer and leader evaluation of micro-teaching experiences. The following materials were produced: 1) Leaders' Syllabus; 2) Trainee Materials; and 3) A set of Divergent Transformation Activities. (AWW)

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INSTRUCTIONAL STRATEGIES FOR CREATIVE HYPOTHESIZING:

A TRAINING PROGRAM

Final Report: Experimental Project 178

PRESERVICE TEACHER TRAINING AND CREATIVITY IN PROBLEM SOLVING:

A DEVELOPMENTAL INVESTIGATION

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Charles E. Gray

Richard C. Youngs

August, 1971

A two year developmental investigation supported by Illinois State University and the Office of the Superintendent of Public Instruction, Gifted Program Development Section.

Conducted in the Metcalf and University High Laboratory Schools
Illinois State University
Normal, Illinois 61761

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INSTRUCTIONAL STRATEGIES FOR CREATIVE HYPOTHESIZING:

A TRAINING PROGRAM

FINAL REPORT

Charles E. Gray

Richard C. Youngs

Teacher Education Project
Illinois State University
Normal, Illinois

PROJECT STAFF AND CONSULTANTS

Directors

Dr. Charles E. Gray (Illinois State University)	Co-Director (1969-71)
Dr. Richard C. Youngs (Illinois State University)	Co-Director (1970-71)
Dr. William B. Legge (Illinois State University).	Co-Director (1969-70)

Research Assistants

Mrs. Marilyn Parmantie (Illinois State University). . . .	Research Assistant and Project Secretary (1969-71)
Mrs. Virginia Davidson (Illinois State University). . . .	Research Assistant (1969-71)
Mrs. Betty Poe (Illinois State University).	Research Assistant (1969-70)
Mrs. Jacqueline Stover (Illinois State University). . . .	Research Assistant (1969-70)
Miss Joan Deutschmann (Illinois State University)	Student Research Assistant (1970-71)

Consultants

Dr. Horace E. Aubertine (Illinois State University) . . .	Consultant (1970-71)
Dr. Gary A. Davis (University of Wisconsin)	Consultant (1969-70)
Dr. J. P. Guilford (University of Southern California). .	Consultant (1970-71)
Dr. Ronald Halinski (Illinois State University)	Consultant (1970-71)
Dr. Eugene H. Jabker (Illinois State University).	Consultant (1969-71)
Dr. Mary N. Meeker (Loyola University, Los Angeles) . . .	Consultant (1970-71)
Dr. Robert Rumery (Illinois State University)	Consultant (1969-71)
Dr. Charles E. Schaefer (Fordham University).	Consultant (1969-70)
Dr. E. Paul Torrance (University of Georgia).	Consultant (1969-70)
Mr. George Troutt (Southern Illinois University, Edwardsville).	Consultant (1969-70)
Creative Problem Solving Institute staff (Buffalo State University College).	Staff consultation (June, 1971)

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ABSTRACT OF PROJECT

A. Objectives

The purpose of the developmental investigation was to develop a concise training program designed to enhance the ability of teachers to facilitate problem-solving behaviors on the part of elementary and secondary school pupils, with particular emphasis on creative hypothesizing.

Specifically, the training program was to be designed to alert teachers to the importance of instruction for creative problem solving, provide them with a sound rationale, and equip them with a repertoire of appropriate teaching strategies and skills.

The training program is being adapted for use in the Illinois State University teacher education program, disseminated through state area service centers, and made available to various institutions and agencies concerned with instruction in creativity.

B. Procedures

The training program was developed by means of a sequential training-instruction-feedback-revision cycle. University students in the junior participation program at the Illinois State University laboratory school were given either minimal instructions (i.e., no training) or a trial training program and consequently given an opportunity to facilitate creative hypothesizing with micro-type groups of laboratory school pupils at a given grade level (K, 3, 7, 10 or 12). The micro-teaching sessions were video-taped and systematically analyzed. Inferences derived from the analyses (and from attitude measures of trainees and creativity measures of laboratory school pupils) were incorporated into subsequent training programs. The cycle was repeated until a training program was developed which was concise,

internally consistent, and enabled trainees to facilitate creative hypothesizing on the part of pupils (i.e., consistent and significant improvement compared with non-trained students).

C. Results

The project has developed a concise instructional sequence which involves direct presentation of content, demonstration of process, analysis of process, modeling, and micro-teaching. It deals with establishing classroom climate, thinking activities based on the Structure-of-Intellect model, brainstorming, attending to the problem, and examining the problem from various vantage points. It also includes techniques for peer and leader evaluation of micro-teaching experiences. The program has had consultative input from J. P. Guilford, E. P. Torrance, M. N. Meeker, G. A. Davis, C. E. Schaefer, the Creative Problem Solving Institute staff (Buffalo, New York), and others. It has been subjected to evaluation which involved over 40 Illinois State University juniors as subjects; the results were favorable. The program efficiently and effectively trained teachers to stimulate students to generate creative solutions to problems and it both teaches and demonstrates exemplary teaching methods.

The final training program is designed for use with either preservice or inservice teachers at all grade levels and in most subject areas.

DIGEST OF PROJECT

The project has developed a concise training program designed to enhance the ability of teachers to facilitate problem-solving behaviors on the part of elementary and secondary school pupils with particular emphasis on creative hypothesizing. The training program alerts teachers to the importance of instruction for creative problem solving, provides them with a rationale, and equips them with a repertoire of appropriate teaching strategies and skills.

The training program was developed over a two-year period at Illinois State University. Preservice teachers were trained using trial programs and they in turn applied their training with laboratory school pupils at five grade levels (K, 3, 7, 10 and 12). The trials were analyzed and evaluated for deficiencies, and consequently the findings were incorporated into a revised training program. This process (or cycle) was repeated until a training program was developed which was concise, internally consistent, and enabled trainees to enhance their ability to facilitate creative hypothesizing on the part of pupils.

The final training program is designed for use with either preservice or inservice teachers at all grade levels and in most subject areas.

INTRODUCTION

A. Cooperative Undertaking

The investigation was initiated as a two-year developmental research project funded jointly by Illinois State University and the Office of the Superintendent of Public Instruction, Gifted Program Development Section. The project was conceived as a cooperative venture designed to narrow the gap between theory and application in an important area of education. The Gifted Program Development Section is concerned with the dissemination of useful ideas and procedures and with program development throughout the State of Illinois. Illinois State University is concerned with the training of teachers and with applied research on teaching. The merging of these interests resulted in a developmental research project wherein Illinois State University would utilize its staff and laboratory school facilities in the development of a specific training program in the area of creative problem solving. In turn the completed program would be incorporated into the Illinois State University teacher education program, and would be disseminated through area service centers and integrated into state-wide programs by the Gifted Program Development Section. Hence, one of the primary objectives of this project was to demonstrate

the efficacy of cooperative undertakings between state agencies interested in stimulating and applying educational research.

B. Rationale

This developmental research project was based upon four important assumptions about creative problem solving and the creative learning process. The first assumption was that creative problem-solving is essential in dealing with the problems confronting individuals and groups in our pluralistic, dynamic, industrial society. Second, that creative problem-solving can be viewed as a logical process involving specific thinking operations. Third, that creative problem-solving can be learned and used by pupils as a heuristic method of thinking and dealing with problems. Fourth, that teachers can be trained to facilitate creative problem-solving behaviors on the part of their pupils.

No better statement of the case for creative problem-solving has been offered than the following succinct paragraph by J. P. Guilford.

> To live is to have problems, and to solve problems is to grow intellectually. It is probably safe to say that at no time has a larger number of informed and otherwise intellectually able individuals lived on this planet, yet the problems to be solved seem almost overwhelming--how to keep the peace, how to feed and clothe an expanding population, how to keep the population from expanding too rapidly, and how to educate it. Education in the more enlightened countries has been rather successful in transmitting to younger generations the accomplishments of older generations. But . . . teaching has been much too authoritative. It has not given the younger generation instruction in how to use information in creative ways, or even the opportunity to do so in many cases. Creative education, on the other hand, aims at a self-starting, resourceful, and confident person, ready to face personal, interpersonal and other kinds of problems. Because he is confident, he is also tolerant where there should be tolerance. A world of tolerant people would be one of peaceful and cooperative people. Thus creativity is the key to education in its fullest sense and to the solution of mankind's most serious problems. (Guilford, 1967)

There is little doubt that new and fresh ideas and approaches are needed in dealing with the multitude of problems confronting contemporary society. Unfortunately, the schools have been only minimally helpful in identifying creative talent or in encouraging creative problem-solving; in fact one noted scholar

maintains that curiosity and free inquiry "are often brutally squelched" in the schools. (Torrance, 1967) If creativity is to be cultivated the school is certainly a place where it could be done early in the child's life, continuously, and systematically. Also, in order to insure maximum transfer of learning creativity should be facilitated in a variety of contexts which have personal meaning and relevance for pupils.

In a pedagogical context creative problem-solving can be viewed as the "creative learning process." Torrance defines this process in terms of the following operations and behaviors:

> Involvement in something meaningful.
>
> Curiosity and wanting to know in the face of wonder, incompleteness, confusion, complexity, disharmony, disorganization, or the like.
>
> Simplification of structure or diagnosing a difficulty by synthesizing known information, forming new combinations, or identifying gaps.
>
> Elaborating and diverging by producing new alternatives, new possibilities, etc.
>
> Judging, evaluating, checking, and testing possibilities.
>
> Discarding unsuccessful, erroneous, and unpromising solutions.
>
> Choosing the most promising solution and making it attractive or aesthetically pleasing.
>
> Communicating the results to others. (Torrance, 1970)

A key element in the creative problem-solving process is that of generating ideas--or hypotheses related to the solution of a given problem. In fact, ideation of this kind is more uniquely creative than any other type of behavior involved in the process. If teachers can learn how to facilitate the generation of multiple hypothesized unique solutions on the part of their pupils, they will have overcome one of the most frustrating obstacles to creative learning. Of course, the ability to facilitate hypothesizing is <u>not</u> an end in itself--and must be learned in a context which clearly reveals its relationship to the total problem-solving process. However, if in learning how to facilitate hypothesizing the teacher has acquired

a rationale and a repertoire of appropriate teaching strategies and skills, he is likely to have a degree of confidence in himself and to be reasonably well prepared to engage in the other phases of the creative problem-solving process. In addition, successful experiences with his newly acquired facilitating ability might very well affect in him a positive attitude toward the importance of instruction for creative problem-solving.

The foregoing assumptions, positions, and considerations regarding the essential and logical nature of creative problem-solving and the teaching-learning relationships of problem-solving represent the basic rationale for this developmental research project. They are subsequently operationalized in the following sections in terms of problem definition, research objectives, experimental design, and procedures.

PROBLEM AND OBJECTIVES

A. The Problem

Hypothesizing is both a central element of and crucial to the success of the creative problem-solving process; it is also the most uniquely creative type of behavior involved in the total process. When teachers have learned how to facilitate hypothesizing they will have in effect learned how to overcome pupil resistance and inhibitions with respect to an important aspect of creative behavior; overcoming such barriers is also important to success with other aspects of the process.

The basic problem with which this investigation was concerned was that of determining the parameters of a training program which would efficiently and effectively train teachers to stimulate the generation of hypotheses on the part of elementary and secondary school pupils; and further, to develop a concise training program consistent with such findings. The end product of the developmental investigation should be a training program which is:

1. Efficient in the sense that it is concise, can be readily mastered by trainees, and can be taught with a minimum expenditure of instructional time.

2. Effective in the sense that it enables trainees to facilitate hypothesizing at a level which is consistently and significantly better than the performance of non-trained subjects.

3. Specifically designed to:

   a. Alert trainees to the importance of instruction for creative problem-solving,

   b. Provide trainees with a sound rationale for such instruction, and

   c. Provide trainees with a repertoire of appropriate teaching strategies and skills.

B. Research Objectives

The problem(s) specified in the preceding section were approached developmentally. The objectives and frame-of-reference of a developmental investigation are somewhat different from those of a more conventional hypothesis testing study. As indicated earlier, the problem under investigation was how to develop a product which can be utilized in the training of teachers. The intent was to build a sound empirical, theoretical, and practical base for the various components of a training program. Throughout the developmental process the following questions served as guidelines for the investigation:

1. What are the basic components that should be included in such a program?

2. How should the basic components be organized within the program?

3. What type of format and procedures should be employed in teaching the program?

4. At what point should the developmental process (and refinements) be terminated? What is the measure of an adequate program?

5. What is the criterion measure(s) to be used in judging a trainee's successful completion of the program?

6. What is the relationship of the training program to the total creative problem-solving process?

The fundamental objective was to develop a useful product--the best possible product that could be devised within the constraints of time and resources imposed upon a small developmental research project.

PROCEDURES: Research Design and Experimental Subjects

A. Developmental Design (cycle)

The training program was developed by means of a sequential training-instruction-feedback-revision cycle (see diagram on page 9). The procedure involved first the training of a group of teacher education students, followed by an opportunity for them to apply their training in an instructional setting; subsequently their performance was carefully analyzed and appropriate revisions made in the training program. Thereupon, the cycle was repeated by training a new group of teacher education students using the revised program.

More specifically, the developmental cycle proceeded in the following manner: Selected University teacher education students in the Junior Participation program at University High and Metcalf laboratory schools were given either minimal instructions (i.e., no training)* or the initial phase of a trial training program (i.e., consisting mainly of exposition, exercises, readings, and modeling). Consequently they applied what they learned by actually engaging in instruction--they were given an opportunity to facilitate creative hypothesizing with micro-type groups of laboratory school pupils at given grade levels (i.e., grades K, 3, 7, 10 or 12). The micro-teaching sessions were video-taped and systematically analyzed by means of the Expanded Interaction Analysis Category System; hypotheses were quantified; laboratory school pupils were controlled with reference to creative ability (Torrance Tests); and trainee attitudes toward creative behavior were measured on a pre-post treatment design. The collected data were subjected to a series of analyses and statistical tests for the purpose of identifying possible relationships between variables and determining possible effects of the training program.

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*An initial group of subjects was given no training in order to obtain base-line data and an estimate of the effects of the "regular" teacher training program on their instructional skill.

PRESERVICE TEACHER TRAINING AND CREATIVITY IN PROBLEM SOLVING: A DEVELOPMENTAL INVESTIGATION

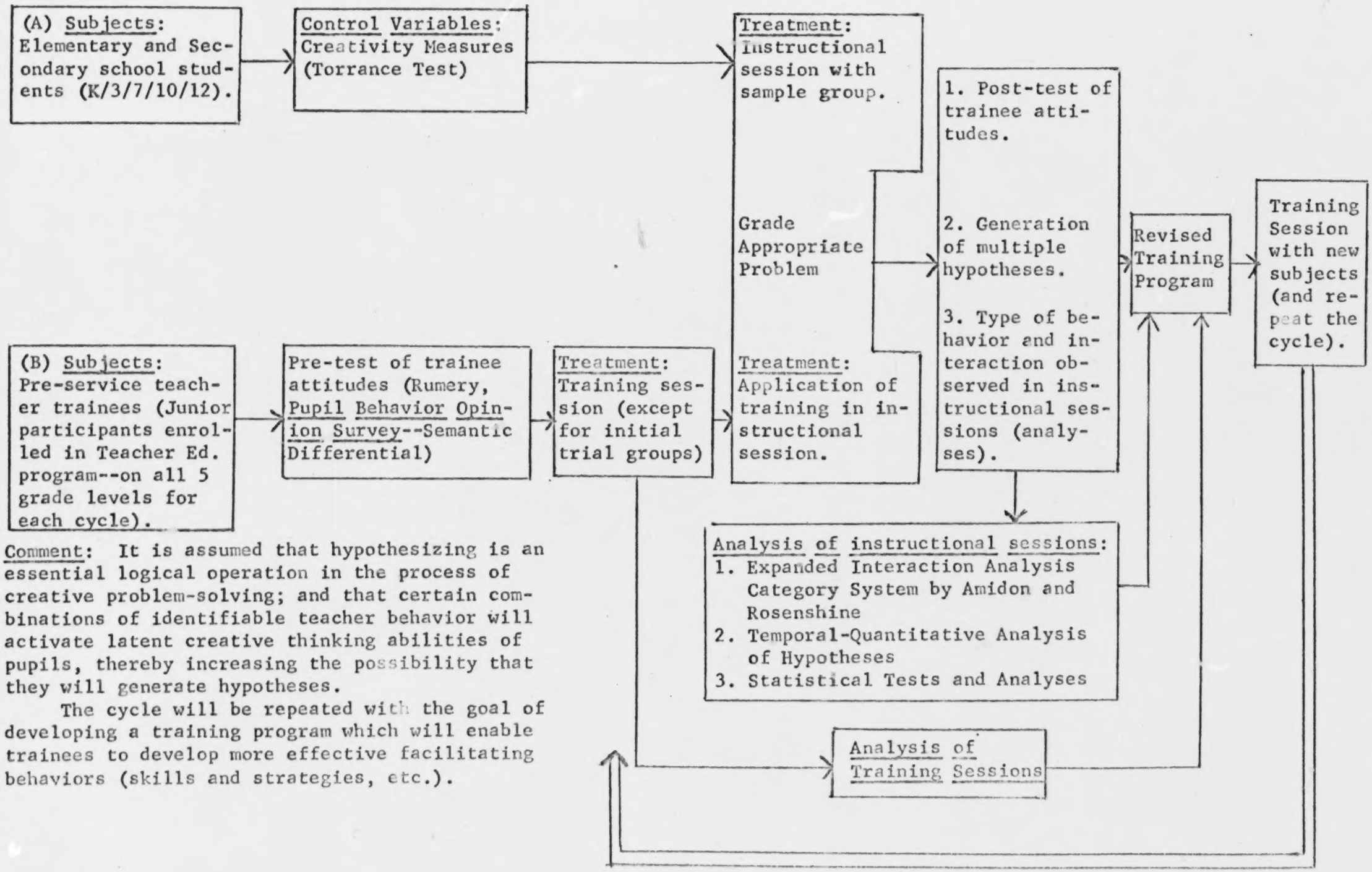
-Training-Instruction-Feedback-Revision Cycle-

OSPI, E-178
ISU, RF-302
RF-815

Subject Population

Independent Variables:
(treatments.....)

Dependent Variables:
(to be used as input for revised training program)


(A) Subjects: Elementary and Secondary school students (K/3/7/10/12).
Control Variables: Creativity Measures (Torrance Test)
Treatment: Instructional session with sample group.
Grade Appropriate Problem
1. Post-test of trainee attitudes.
2. Generation of multiple hypotheses.
3. Type of behavior and interaction observed in instructional sessions (analyses).
Revised Training Program
Training Session with new subjects (and repeat the cycle).
(B) Subjects: Pre-service teacher trainees (Junior participants enrolled in Teacher Ed. program--on all 5 grade levels for each cycle).
Pre-test of trainee attitudes (Rumery, Pupil Behavior Opinion Survey--Semantic Differential)
Treatment: Training session (except for initial trial groups)
Treatment: Application of training in instructional session.
Analysis of instructional sessions:
1. Expanded Interaction Analysis Category System by Amidon and Rosenshine
2. Temporal-Quantitative Analysis of Hypotheses
3. Statistical Tests and Analyses
Analysis of Training Sessions

Comment: It is assumed that hypothesizing is an essential logical operation in the process of creative problem-solving; and that certain combinations of identifiable teacher behavior will activate latent creative thinking abilities of pupils, thereby increasing the possibility that they will generate hypotheses.

The cycle will be repeated with the goal of developing a training program which will enable trainees to develop more effective facilitating behaviors (skills and strategies, etc.).

Inferences derived from the analyses and procedures were incorporated into subsequent training programs. The cycle was repeated until a training program was developed which was concise, internally consistent, and enabled trainees to facilitate creative hypothesizing on the part of pupils at a level consistently and significantly better than the performance of non-trained subjects.

B. Experimental Subjects

Trainees. University teacher education students in the Junior Participation program* at the University High and Metcalf laboratory schools were selected to participate in the research project in lieu of their "regular" participation program. Prospective trainees were informed that participation in the project would provide them with an experience which would be as useful and as valuable to them as the more conventional type of participation activities and that the experience would include (1) special classroom instruction, (2) teaching of pupils at appropriate grade level, and (3) an opportunity to analyze a video-tape of their teaching performance. Three criteria for selection of trainees were used:

1. Is their participation assignment at the appropriate grade level (i.e., grade K, 3, 7, 10 or 12)?
2. Are they available at the appropriate times?
3. Are they willing to volunteer for a Junior Participation experience that will be somewhat different from that of their peers?

Other criteria (e.g., sex, personality, intelligence, socio-economic status, race, etc.) were not considered inasmuch as the training program under development was intended to be "successful" despite unique personal and social variations.

Through the cooperation of a number of Illinois State University faculty members who teach elementary and secondary methodology courses an adequate number of

---

*The Junior Participation program provides a systematic opportunity to teacher education students at Illinois State University to observe and participate in "real" classroom activities under the supervision of a practicing classroom teacher.

trainee subjects were made available for each of the various phases of the developmental investigation. Ten trainees were utilized during the "no-training" phase, ten during the "first training" phase, and ten during the "second training" phase. In addition, nine trainees (both inservice and preservice) enrolled in a summer workshop (1971) were utilized for a final trial run of the training program.

Pupils. The target populations utilized for the trial instructional attempts of the trainee subjects were University High and Metcalf laboratory school pupils at grades K, 3, 7, 10 and 12. Pupil subjects were organized into small micro-type groups for the trial instructional sessions. The following criteria for selection were employed in formulating the groups:

1. Availability. Pupils must have schedules which would make them available for participation in the groups at the times when trainees, project staff, physical facilities, and necessary equipment were also available (basically a problem of logistics).

2. Convenience. Insofar as possible pupil participation should result in only minimal interruptions in regular school programs, and should not unduly interfere with individual pupil's programs of study.

3. Grade level. Pupils must be drawn from the appropriate grade levels as needed (grades K, 3, 7, 10 and 12).

4. Group size. Each micro-teaching group must consist of no more than six (6) or no fewer than four (4) pupils. Insofar as possible group size should be limited to 5 pupils.

5. Creative ability. Each micro-teaching group should include a range of pupil creative ability (as measured by the Circles Test of the Rogge adaptation of the Minnesota Tests of Creative Thinking). Insofar as possible each micro-teaching group should include one pupil near or above Q_3, two or more pupils between Q_1-Q_3, and one pupil near or below Q_1 (based on local normative data).

6. Sex. Each micro-teaching group must include both male and female subjects. Insofar as possible a balance of 3 of one sex and 2 of the other should be maintained.

7. Non-repetition. The same pupils must not be used in repetitive micro-teaching instructional sessions in order to avoid inter-treatment contamination.

The criteria of availability, convenience, grade level, and non-repetition were satisfactorily implemented through cooperative planning with the laboratory school administration and faculty. Occasional difficulty was experienced with

regard to group size and sex, due to pupil absences and other unavoidable circumstances. (See data dealing with these two factors in Appendix A).

In an effort to implement the criterion of creative ability, selected parts of the Rogge adaptation of the Minnesota Tests of Creative Thinking were administered to all laboratory school pupils in grades K, 3, 7, 10 and 12 during each year of the project. This was undertaken in order to insure as large a tested target population as possible each year, and to have data available for the calculation of local norms. With the test data available it was possible to select pupil subjects during the first year on the basis of their total test scores. During the second year it was possible to select subjects on the basis of their test scores on the Circles Test only (based on the established norms and the results of a factor analytic study of the test results--see Appendix B). Unfortunately, the investigators were unable to implement the creative ability criterion as completely as had been hoped, since on occasion pupils who were needed to fill-out a given micro-group were unavailable at the appropriate time due to unforseen scheduling difficulties or personal problems. However, in the vast majority of instances the micro-groups did include a satisfactory range of creative abilities; an analysis of percentile ranges is included, with notations, in Appendix A.

PROCEDURES: Development of Training Program

A. FIRST TRAINING PROGRAM	B. SECOND TRAINING PROGRAM	C. THIRD TRAINING PROGRAM
1. Probing Trial Sessions a. Trial micro-teaching sessions with investigators as instructors and using pupils from non-target populations (grades 1, 8, and 11). (Video-taped)	1. Probing Trial Sessions a. Trial micro-teaching sessions with investigators as instructors and using pupils from non-target populations (secondary and elementary pupils).	1. Probing Trial Sessions a. Trial application of portions of instructional and micro-teaching phases of Third Training Program (using summer workshop trainees and 6th grade pupils).
2. Micro-teaching Sessions (No-Training Group) a. Selection of pupils from grades K, 3, 7, 10 and 12 b. Selection of trainees c. Measurement of trainee attitude (pre-post treatment design) (See Appendix C) d. Trainee instructional session: Minimal Instructions e. Micro-teaching session with pupils (video-taped) f. Recording of session data: 1. Interaction analysis (see Appendix D) 2. Hypotheses (see Appendix E) 3. Session length 4. Participation dispersion	2. Micro-teaching Sessions (First Training Group) a. Selection of pupils from grades K, 3, 7, 10 and 12 b. Selection of trainees c. Measurement of trainee attitude (pre-post treatment design) (See Appendix C) d. Trainee instructional session: First Training Program e. Micro-teaching session with pupils (video-taped) f. Recording of session data: 1. Interaction analysis (see Appendix D) 2. Hypotheses (see Appendix E) 3. Session length 4. Participation dispersion	2. Micro-teaching Sessions (Second Training Group) a. Selection of pupils from grades K, 3, 7, 10 and 12 b. Selection of trainees c. Measurement of trainee attitude (pre-post treatment design) (See Appendix C) d. Trainee instructional session: Second Training Program e. Micro-teaching session with pupils (video-taped) f. Recording of session data: 1. Interaction analysis (see Appendix D) 2. Hypotheses (see Appendix E) 3. Session length 4. Participation dispersion
3. Consultative and Evaluative Input a. Nonmetric Multidimensional Scaling procedure (see Appendix F)	3. Consultative and Evaluative Input a. Nonmetric Multidimensional Scaling procedure (see Appendix F)	3. Consultative and Evaluative Input a. Nonmetric Multidimensional Scaling procedure (see Appendix F) (not applied to second training group)

Continued.....

Continued.....

Continued.....

FIRST TRAINING PROGRAM	SECOND TRAINING PROGRAM	THIRD TRAINING PROGRAM
b. Literature search: E. Paul Torrance and Sidney Parn s	b. Literature search: J. P. Guilford, Mary Meeker, Sidney Parnes, and W. J. J. Gordon	b. Literature search: J. P. Guilford and E. Paul Torrance
c. Consultation: E. Paul Torrance	c. Consultation: Charles E. Schaefer and Gary Davis	c. Consultation: J. P. Guilford, Mary Meeker, and Creative Problem Solving Institute
		d. Comparative Analysis of No-Training, First Training, and Second Training Programs (see following section and Appendix G)
4. Application of Findings and Recommendations:	4. Application of Findings and Recommendations:	4. Application of Findings and Recommendations:
a. Development of First Training Program (to be used as input for development of Second Training Program)	a. Development of Second Training Program (to be used as input for development of Third Training Program)	a. Development of Third Training Program (to be used in training of teachers and trainers)

D. Comparative Analysis of No-Training, First Training, and Second Training Programs (See also Appendix G)

This project was primarily developmental in nature. To have imposed a rigorous experimental design at the outset would have been inhibitive. Yet the responsibility of accumulating evidence for the evaluation of the "product" remains. The research design which evolved from these two considerations could be classified as "quasi-experimental."

Data were collected for three groups of preservice teachers. The first group of 10 teachers received no training. The second group of 10 teachers was exposed to the first training program developed. This program was then revised and a third group of 10 teachers was trained under this modified program. While the preservice teachers were not randomly assigned to the three groups, they were

similar with respect to the criteria for selection discussed in the preceding section of this report.

To measure the effects of the training programs students were selected from those enrolled at the Illinois State University laboratory schools in grades K, 3, 7, 10 and 12. Micro-groups of four to six students were formed on the basis of scores on the Minnesota Tests of Creative Thinking (Rogge adaptation) in order to secure reasonably comparable groups along this dimension. Six such groups were formed at each grade level. Each group was involved in a single micro-teaching session taught by one teacher who was either untrained or trained under one of the two programs. The micro-teaching sessions were video-taped and these tapes provided the basic data for analysis. The sampling unit employed in the data analysis was the micro-group.

The principal dependent variable of interest was the number of hypotheses generated in each micro-group. The length of each micro-session was not controlled in the research design, and since this variable can be expected to have an effect on the number of hypotheses generated, it was controlled statistically. Bottenberg and Ward (1) describe the appropriate linear regression models to use. The analysis indicates that preservice teachers trained under either of the two programs would be more effective in eliciting hypotheses from students than would preservice teachers who were not trained. However, there was no evidence to suggest a difference in the overall effectiveness of the two training programs. The cumulated number of hypotheses were then plotted as a function of time for each preservice teacher (Appendix H). It appeared that the initial segment of the sessions for preserivce teachers trained under the second program was a period of rapid hypothesizing. (The median length of this period was 11 minutes.) Further, the remainder of the sessions was almost totally nonproductive in most instances. These results are summarized in Table 1.

TABLE 1

COMPARISON OF INITIAL AND REMAINING SEGMENTS OF MICRO-SESSIONS

Training Program	Initial Segment (11 minutes maximum)		Remainder of Session	
	Time (Minutes)	No. of Hyp.	Time (Minutes)	No. of Hyp.
First	119	100	140	122
Second	121	151	145	55

The difference in the number of hypotheses generated in the first 11 minutes was significantly greater for the preservice teachers trained under the second program.

Differences in the length of session can also be taken into account in the formation of a "productivity" index, namely, the number of hypotheses generated per minute. The data analysis incorporating this dependent variable substantiated the results previously reported.

Student divergent responses, as described in the Expanded Interaction Analysis Category System, served as a further basis for studying the effects of the training programs. The analysis suggests the superiority of the first training program over the second in this respect. Further, the second training program appeared to be no more effective than no training at all. When the two training programs are compared for the first eleven minutes of the sessions only, the evidence still points in the direction of the first training program as being more effective (Significance level = .10) along this dimension.

When student talk is considered as a dependent variable there was no evidence of any one group of preservice teachers being more effective than the others in getting the student to do the talking.

Finally, the two training programs appear to have little effect, if any, on the attitude of preservice teachers toward pupil behavior associated with creativity.

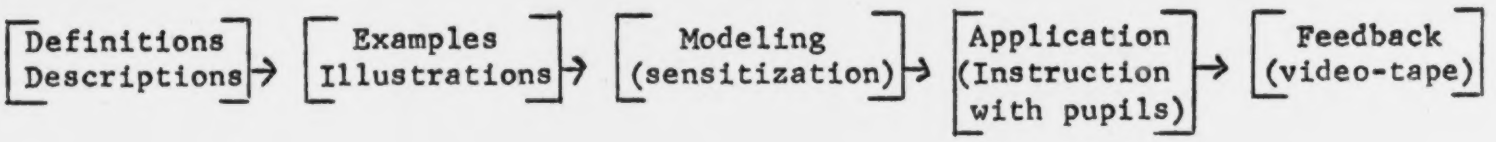
In summary, these results suggest that the impact of the second training program occurs in the early stages of a session. It is during this time that hypotheses were generated rapidly and in large numbers. Further, when compared with the first training program this appears to have been accomplished with less reliance on other types of divergent responses. (See Appendix G for detailed description of comparative analysis.

FINDINGS AND CONCLUSIONS

A. First Training Program

Program Theme and Components. The dominant theme of the first training program was classroom climate, namely, ways and means of establishing the type of classroom atmosphere (or environment) which would be most likely to stimulate divergent thinking on the part of pupils. In order to accomplish this objective the program included components designed to alleviate trainee apprehensions and uncertainties regarding the idea of divergent thinking as an ingredient of the problem-solving process in a classroom setting, and to equip the trainee with a repertoire of techniques which he could utilize in encouraging pupils to view learning tasks in imaginative and unusual ways. The program emphasized such climate-related topics as the following: (1) Avoidance of excessive evaluation, (2) Judicious use of silence, (3) Student initiated talk and interaction, (4) Clarity and explicitness of communication, (5) Divergent questioning procedures, and (6) Probing questions. For each topic, instruction included a study of definitions and appropriate examples; this was followed by a sensitizing session (with trainees as pupils) wherein the investigator modeled the previously discussed types of teacher behavior in an effort to stimulate divergent thinking and elicit multiple

hypotheses on the part of the trainees. Consequently, each trainee demonstrated his application of the teaching behaviors with a micro-group of pupils and viewed the video-tape of his performance. A schematic representation of the mode of instruction would be as follows:



(See Appendix J for outline of First Training Program)

Developmental Input. The training program described above was developed on the basis of (a) an analysis of the data collected from the No-Training Group, (b) findings and recommendations in contemporary literature on creative problem-solving, and (c) the advice of project consultants.

As a result of conferences with trainees and repeated observations of micro-teaching sessions it became apparent that both trainees and pupils were unaccustomed to viewing learning tasks in imaginative and creative ways. In particular, the trainees exhibited a marked degree of apprehension and uncertainty about dealing with divergent-type behavior in a pedagogical context. These observations tended to confirm similar findings in the literature. Therefore, on the basis of such findings and upon the recommendation of project consultants, it was decided that the concept of "climate" should be incorporated as a pervasive element into both the training program and the micro-teaching sessions.

An examination of the interaction analysis data revealed what appeared to be certain precursive events which tended to facilitate, maintain, or inhibit subsequent sequences of divergent behavior on the part of pupils. The following data from the first series of micro-teaching sessions illustrates this tendency.

Divergency Sequences Begun After...	% of Time	Divergency Sequences Ended After...	% of Time
Questions	41	Evaluation	39
Fact	25	Question	27
Evaluation	16	Fact	17
Praise	4	Praise	9
Acknowledgment	4	Acknowledgment	3
Lecture	4	Clarification	3
Statement	2	Silence	2
Answer	2		
Directions	2		
	100		100

These data were useful in developing the training program, but at the same time they were seemingly contradictory in certain respects. For instance, is it possible that some factual, evaluative, or questioning statements stimulate and others inhibit divergent thinking? These and similar questions prompted the investigators to undertake a more sophisticated analysis of the micro-session interaction analysis data in an attempt to ascertain possible relationships between various types of trainee and pupil behavior. The preliminary results of the analysis procedure (known as MDSCAL) tended to support the decision to emphasize climate-related components in the First Training Program. (The completed MDSCAL analysis was not available until the developmental stage of the Second Training Program: See Appendix F).

The interaction analysis data also revealed what appeared to be a disproportionate amount of instructional time consumed with non-divergent student and trainee talk (see Appendix I). Extremely long periods of descriptive discourse ensued and trainees appeared to be somewhat at a loss for appropriate techniques, questions, or strategies that might be used to stimulate divergent thinking and hypotheses from pupils. These findings emphasized the need for specific questioning and probing procedures in the training program.

The pre-post training measurement of trainee attitude toward creative behavior provided the following information: (1) 80% had either no change or a negative shift in attitude, and (2) the mean negative shift in attitude for the group (N-10) was 11.9 points. Although not statistically significant, the results

certainly indicated that the experiences of the No-Training Group (i.e., minimal instructions, micro-teaching, and video-tape feedback) did not enhance their positive attitudes toward creative behavior. This finding once again reinforced the decision to emphasize classroom climate in the training program and to provide trainees with skills and procedures which would increase their confidence in their ability to elicit and deal with divergent responses. At this point the decision was also made to include a sensitizing session in the training program for the purpose of making trainees confortable with the process (while at the same time analyzing the model performance of their instructor).

The efficacy of the micro-teaching and video-tape feedback aspects of the training program is well documented in recent educational research (Borg 1970, Flanders 1970). Such procedures were easily built into the training program; and they served the dual function of (a) performance feedback for the trainees, and (b) a reliable source of data for the developmental research project.

B. Second Training Program

Program Theme and Components. The Second Training Program retained the classroom climate theme of the first program with the addition of a set of instructional strategies designed to more efficiently stimulate hypothesizing on the part of pupils. Both the classroom climate and the instructional strategies components were integrated into a basic procedure for brainstorming hypotheses. The classroom climate component included such elements as: (a) Student Talk--Quantity, (b) Teacher Talk--Phrasing, (c) Silence, (d) Student Talk--Dispersion, (e) Evaluation, (f) Respect, (g) Feedback Sensitivity, and (h) Student Talk--Ideas. The instructional strategies component included such elements as: (a) Thinking Activities based on the Structure-of-Intellect model, (b) Stating the Problem, (c) Brainstorming, and (d) Divergent Excursions (a type of questioning strategy designed to maintain focus on various aspects of the problem, stimulate divergent-type thought related to the problem, and kindle the generation of additional

hypotheses). Instruction included direct presentation of content, demonstration of process, analysis of process, modeling, micro-teaching, evaluation of performance, recycling (if needed), and summation. In general, the mode of instruction was similar to that of the First Training Program. Appendix K includes a figural summary of the Second Training Program (as well as a content outline, climate guidelines, an overview and summary of the brainstorming hypotheses procedures, and a summary of transformation activities).

Developmental Input. The training program described above was developed on the basis of (a) an analysis of the data collected from the First Training Group (i.e., trained using the First Training Program), (b) findings previously discussed relative to the No-Training Group, and (c) the advice of project consultants.

Data from the developmental trials of the First Training Program were analyzed in a number of ways in an effort to gain useful insights for the development of the Second Training Program. Based upon a quantitative analysis of hypothesizing in the micro-teaching sessions it was found that trainees had generated a significantly greater number of hypotheses than had been the case with the untrained subjects (see Appendices G and I). Based upon the MDSCAL analysis of the interaction analysis data there appeared to be: (1) A relationship between divergent questions and divergent responses. (2) A relationship between descriptive talk and evaluative talk. (3) No relationship between teacher-pupil evaluative talk and divergent responses. (4) No relationship between descriptive talk and divergent responses. (5) Little or no relationship between teacher praise-acceptance and divergent responses. (See Appendix F) Based upon an analysis of the results of the measurement of trainee attitude toward creative behavior it was found that there were no significant differences at any of the grades K, 3, 7, or 10. However, the attitude of the First Training Group at grade 12 was significantly more positive than that of the No-Training Group at that grade level (see Appendix G). Based upon conferences with trainees, repeated observations of micro-teaching sessions, and consultant evaluations it was concluded that:

(a) The micro-teaching sessions continued to contain extended periods of non-productive descriptive and/or evaluative discourse.

(b) The trainees lacked a basic teaching strategy with which to keep the sessions moving in the direction desired.

(c) The training program was eclectic in nature and lacked a consistent conceptual structure and a sound theoretical base upon which a set of teaching strategies might be built.

(d) The training program was in need of refinement and clarification in order to make it useful for teacher-trainers.

Consistent with the foregoing findings and conclusions the following guidelines were employed in the development of the Second Training Program:

(1) Since the First Training Program was reasonably successful in terms of hypothesis generation, its basic classroom climate components should be retained and refined.

(2) The program should discourage evaluative and descriptive discourse and should emphasize teacher praise-acceptance only to the extent that it was emphasized in the previous program.

(3) The training experience should be made as pleasant and as worthwhile as possible for the trainees.

(4) A strategy for facilitating hypotheses should be developed which is consistent in terms of conceptual structure, built upon a sound theoretical base, and can be logically integrated with the climate components of the previous program.

(5) An instructor's manual (or syllabus) should be developed suitable for use by non-project personnel in the training of teachers.

The Guilford or Structure-of-Intellect model is a well-documented and well-researched attempt to identify and organize thinking abilities. The divergent thinking portion of the Structure-of-Intellect was used as the theoretical base for the Second Training Program. Both the Divergent Transformation Activities and the Divergent Excursion strategy are based upon the SOI model. The Divergent Transformation Activities are designed to enhance classroom climate and develop pupil divergent transformation skills. The Divergent Excursion strategy is a questioning strategy designed to maintain focus on various aspects of the problem, stimulate divergent-type thought related to the problem, and kindle the generation of additional hypotheses. (See Appendix K.)

C. Third Training Program

Program Theme and Components. The Third Training Program retained the major elements of the integrated brainstorming hypotheses procedures and the mode of instruction of the second program. The brainstorming hypotheses procedures included classroom climate and instructional strategies components and utilized the Structure-of-Intellect model as a theoretical base. The mode of instruction included direct presentation of content, demonstration of process, analysis of process, modeling, micro-teaching, evaluation of performance, recycling (if needed), and summation. Minor changes between the two programs consisted of a number of content adjustments, clarifications, and editorial refinements. Major changes included the following: (1) More thorough evaluation procedure for trainees (including minimum performance standard). (2) More complete recycling procedure for trainees (including diagnostic graphs). (3) Substantially revised presentation of the Structure-of-Intellect model. (4) Presentation of two complete creative problem-solving models. (5) More intensive use of video-tapes for analysis and evaluation. (6) Greater attention to the nature of hypotheses and hypothesizing. (7) Additional group work and participation of trainees in training sessions. Appendix L includes a figural summary of the Third Training Program (as well as a content outline, an overview and summary of the brainstorming hypotheses procedures, a summary of transformation activities, a description of Structure-of-Intellect, guidelines for identifying hypotheses, and a graph illustrating the minimum performance standard). The complete program is entitled, Instructional Strategies for Creative Hypothesizing: A Training Program. The following materials have been produced for use in the training of teachers: (1) Leaders' Syllabus (loose-leaf notebook), (2) Trainee Materials (loose-leaf notebook), and (3) a set of Divergent Transformation Activities (boxed).

Developmental Input. The training program described above was developed on the basis of (a) an analysis of the data collected from the Second Training Group (i.e., trained using the Second Training Program), and a summer workshop group, (b) findings previously discussed relative to the No-Training and First Training Groups, (c) findings and recommendations in contemporary literature on creative problem-solving, and (d) the advice of project consultants.

Data from the developmental trials of the Second Training Program were analyzed and compared with the earlier trials. In addition, the complete training program was made available to several independent consultants for evaluation.* Appropriate revisions were made and consequently a final trial was undertaken using a group of inservice and preservice teachers in a University summer workshop.

The comparative analysis of the training programs revealed that the impact of the Second Training Program occurred in the early stages of the micro-teaching sessions. During the first few minutes hypotheses were generated rapidly and in large numbers. When compared with the First Training Program this rapid hypothesizing appears to have been accomplished with less reliance on other types of divergent responses. (See Appendix G)

The evaluative consultants were quite favorable in their reaction to the training program. Their suggestions and recommendations included the following: (a) Minor changes in order of content presentation, (b) Adjustments in Structure-of-Intellect definitions, (c) Revision of certain Structure-of-Intellect examples and activities, (d) Additional group work and participation in training sessions, (e) Use of visual projections during training sessions, (f) Charting of different types of performance (i.e., inadequate, adequate, excellent, etc.), (g) Inclusion of complete problem-solving process, (h) Establishment of criterion performance standard.

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*Consultants were: J. P. Guilford (University of Southern California); Mary N. Meeker (Loyola University, Los Angeles); Ronald Halinski (Illinois State University); Horace E. Aubertine (Illinois State University); and Eugene H. Jabker (Illinois State University).

Based upon the foregoing findings and recommendations the series of revisions discussed in the first part of this section were effected and the revised program was applied with the group of workshop trainees. The trial was not controlled as previously, and only limited data were collected. However, the results were favorable in terms of general trainee acceptance and interest and the new or revised program elements appeared to improve instruction. One of the more interesting findings was that the workshop group generated hypotheses at a rate above that of previous groups. This is illustrated in the following table:

TABLE 2

COMPARISON OF HYPOTHESES-PER-MINUTE IN INITIAL SEGMENTS OF MICRO-SESSIONS

	Initial Segment (11 minutes maximum)*		
Training Program	Time (Minutes)	Number of Hypotheses	Hypotheses Per Minute
First (10 sessions)	119	100	.84
Second (10 sessions)	121	151	1.24
Third (3 sessions) (Workshop)	33	45	1.36

*Adapted from Table 1, page 16.

In essence, the Third Training Program amounted to a final revision designed to retain the strengths and remedy the shortcomings of previous programs. The initial trial of the program appeared to support the expectations of the investigators.

IMPACT OF INVESTIGATION AND RECOMMENDATIONS FOR FURTHER RESEARCH

A. Impact of Developmental Investigation

As indicated in the introduction the developmental investigation was conceived from its inception as a cooperative venture designed to narrow the gap between theory and application. It was funded jointly by Illinois State University and the Office of the Superintendent of Public Instruction, Gifted Program Development Section. The final training program will be adapted for use in the elementary and secondary professional education sequences at Illinois State University and disseminated through the area service centers of the Gifted Program Development Section. The project has produced a supply of necessary training materials which will be utilized in a series of workshops to train leaders; both Gifted Program Development Section staff and Illinois State University faculty will be trained to use the training program with inservice and preservice teachers.

The project has had considerable impact on educational thinking at Illinois State University and elsewhere. Several faculty members served as consultants, others assisted in the solving of logistical problems, and still others helped in devising ways of incorporating the program into the professional sequences. In the process considerable interest and enthusiasm was generated relative to the project's rationale, training techniques, and product. In particular, a number of faculty members are interested in further applications of the theoretical base utilized in the training program. As a result, an invitational Structure-of-Intellect Conference will be held on the Illinois State University campus in the fall of 1971. The conference theme will be to explore the implications of the Structure-of-Intellect model for teaching and education (conference speakers include J. P. Guilford and Mary N. Meeker). As a result of contact with the project, Frederick McDonald of the Educational Testing Service has indicated an interest in applications of the model in evaluating teaching. The College of Education is considering the establishment of a teacher education center which would include

exploration of applications of the SOI model as one of its major thrusts. Recently another developmental investigation was jointly funded by OSPI and ISU; it is an outgrowth and continuation of the present project. It will be directed by Richard C. Youngs and will capitalize on the teacher training techniques developed herein in an effort to train teachers to develop pupil thinking ability through Structure-of-Intellect activities.

Thus, in addition to producing a useful product in the area of creative problem-solving, the project has stimulated thought and served as a catalyst for a number of potentially significant undertakings at Illinois State University and elsewhere.

B. Recommendations for Further Research

As indicated above, both the educational applications of the Structure-of-Intellect model and the teacher training techniques developed by the project are being considered (or utilized) for other or related investigations. With respect to the final training program the investigators are interested in applying it on a large scale in the training of teachers; experience in its use will no doubt suggest further refinements and applications. Three lines of research might be worthwhile in the future. One would be to combine the training program with one of the complete creative problem-solving models and assess the effects on teachers and/or pupils. The second would be to develop an instrument or technique for measuring the effects of the training program on either preservice or inservice teachers in the classroom. Finally the program should be tested in a rigorous fashion using a larger and more varied sample of pupils and trainees. Follow-up studies of this type however, are all too rare in the realm of educational research.

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APPENDIX A

ANALYSIS OF PERCENTILE RANGES OF MICRO-GROUPS ON CIRCLES TEST **
(Rogge adaptation: Minnesota Tests of Creative Thinking)

TRAINING PROGRAM	TRAINEE NAME	GROUP GRADE LEVEL	GROUP SEX DIST.	GROUP HIGH (%ile)	GROUP LOW (%ile)	GROUP RANGE (%ile)	GROUP MED. (%ile)	PERCENT OF GROUP IN $Q_1 - Q_3$
NO TRAINING	York	K	3f/2m	98	33	65	73	60%
	Anderson	K	3f/2m	57	17	40	48	80%
	Pitts	3	3f/2m	91	28	63	78	40%
	Keller	3	3f/2m	52	20	32	52	60%
	Johnson	7	2f/3m	96	83	#13	90	00%
	Paulson	7	2f/3m	58	10	48	26	80%
	Wegner	10	2f/3m	59	06	53	28	80%
	Ahrens	10	3f/2m	96	28	68	36	80%
	Denker	12	2f/2m	55	22	33	35.5	75%
	Hout	12	2f/3m	96	01	95	70	40%

#Small range size due to error in selection procedure.

Note: Micro-group percentile ranges varied from a low of 13 to a high of 95, with the median group range being 50.5. All micro-groups (with the exception of one) contained 40% or more pupils between Q_1 and Q_3.

FIRST TRAINING	Faikus	K	2f/3m	85	28	57	57	60%
	Hagensick	K	3f/2m	71	08	63	*39.5	60%
	Steiner	3	3f/2m	91	28	63	73	80%
	Corry	3	3f/1m	96	20	76	*58	50%
	Hoffman	7	2f/3m	79	13	66	45	40%
	Dietel	7	2f/2m	92	26	66	*59	75%
	Dame	10	3f/2m	81	15	66	72	40%
	Nelson	10	3f/2m	89	06	83	67	60%
	Whisker	12	2f/2m	70	16	54	24.5	50%
	Veach	12	3f/2m	70	11	59	44	60%

*Med. est.: 2 untested pupils.
*Med. est.: 1 untested pupil.
*Med. est.: 1 untested pupil.

Note: Micro-group percentile ranges varied from a low of 54 to a high of 83, with the median group range being 64.5. All micro-groups contained 40% or more pupils between Q_1 and Q_3.

SECOND TRAINING	Toomey	K	3f/2m	76	25	51	48	80%
	Sherry	K	1f/4m	80	25	55	48	80%
	Wycislo	3	3f/2m	91	28	63	59	60%
	McTee	3	3f/2m	86	20	66	52	40%
	Dvorak	7	2f/3m	79	40	39	68	60%
	Trigg	7	4f/1m	83	34	49	64	80%
	Moran	10	3f/2m	86	02	84	51	60%
	Tinley	10	2f/4m	96	01	95	47.5	33%
	Rankin	12	2f/3m	55	02	53	38	60%
	Ransford	12	2f/4m	70	02	68	27.5	50%

Note: Micro-group percentile ranges varied from a low of 39 to a high of 95, with the median group range being 64.5. All micro-groups (with the exception of one) contained 40% or more pupils between Q_1 and Q_3.

** Percentiles based on local norms for each grade level (see Appendix B)

APPENDIX B

FACTOR ANALYSIS OF TORRANCE-ROGGE TESTS OF CREATIVITY* (AND LOCAL NORMS)

Prior to establishing local norms for subtests of the Torrance-Rogge Tests of Creativity, a factor analysis of intercorrelations was undertaken in the interests of construct validation. Scores were obtained for a total of 414 children in Kindergarten and Grades 3, 7, 10 and 12 in the laboratory schools of Illinois State University. The composition of the sets of subtests given at the various levels is presented in Table 1. In addition, the Stories subtest, scored for originality and interest was administered in Grades 10 and 12.

TABLE 1

GRADE LEVEL ALLOCATION OF SUBTESTS AND PART SCORES
TORRANCE-ROGGE TESTS OF CREATIVITY

Subtest	Part Scores			
	Fluency	Originality	Elaborateness	Flexibility
Circles	All Levels	All Levels	All Levels	All Levels
Tom, The Piper's Son	All Levels	All Levels	All Levels	7, 10, 12
Toy Dog	All Levels	All Levels	N/A	All Levels
Tin Cans	7, 10, 12	7, 10, 12	N/A	7, 10, 12

The provision for separate scores in fluency, originality, elaborateness, and flexibility suggests that these represent separate aspects of creativity which generalize across tests of differing content and across age levels. Factor analysis of intercorrelations among subtests at each level provided a basis for

*Rogge adaptation of Minnesota Tests of Creative Thinking (by E. Paul Torrance). Appendix B was written by Robert Rumery, project evaluation consultant.

evaluating these assumptions. The factor solution used was principal components analysis followed by Varimax rotation of factors with associated characteristic roots larger than unity. This solution produces a structure in which the number of factors characterizing any test is minimized and in which common factors are uncorrelated.

The results of the analysis are presented in Tables 2-6. In each table, only factor loadings in excess of .40 are indicated, regardless of sign. The tabled loadings are rotated loadings.

TABLE 2

ROTATED FACTOR LOADINGS OF TORRANCE-ROGGE TESTS OF CREATIVITY
KINDERGARTEN, N=27

			I	II	III	IV
Circles:	Fluency	1				.922
	Originality	2			.973	
	Elaborateness	3				.882
	Flexibility	4			.974	
Tom:	Fluency	5	-.975			
	Originality	6	-.892			
	Elaborateness	7	-.788			
Toy Dog:	Fluency	8		.907		
	Originality	9		.954		
	Flexibility	10		.937		

TABLE 3

ROTATED FACTOR LOADINGS OF TORRANCE-ROGGE TESTS OF CREATIVITY
GRADE 3, N=48

			I	II	III
Circles:	Fluency	1		-.852	
	Originality	2		-.876	
	Elaborateness	3			.814
	Flexibility	4		-.877	
Tom:	Fluency	5	.813		
	Originality	6	.817		
	Elaborateness	7	.647		
Toy Dog:	Fluency	8	.840		
	Originality	9	.817		
	Flexibility	10	.669		

TABLE 4

ROTATED FACTOR LOADINGS OF TORRANCE-ROGGE TESTS OF CREATIVITY
GRADE 7, N=68

			I	II	III	IV	V
Circles:	Fluency	1	.911				
	Originality	2	.905				
	Elaborateness	3	.777				
	Flexibility	4			-.692		
Tom:	Fluency	5					
	Originality	6				.691	
	Elaborateness	7					
	Flexibility	8		-.605			
Toy Dog:	Fluency	9				.743	
	Originality	10			-.640		
	Flexibility	11		.773			
Tin Cans:	Fluency	12		.682			
	Originality	13					.834
	Flexibility	14				.466	

TABLE 5

ROTATED FACTOR LOADINGS OF TORRANCE-ROGGE TESTS OF CREATIVITY
GRADE 10, N=122

			I	II	III	IV	V	VI
Circles:	Fluency	1	.930					
	Originality	2	.933					
	Elaborateness	3	.765					
	Flexibility	4				-.660		
Tom:	Fluency	5			.560			
	Originality	6						.791
	Elaborateness	7			.585			
	Flexibility	8			.468			
Toy Dog:	Fluency	9						.772
	Originality	10					.577	
	Flexibility	11		-.752				
Tin Cans:	Fluency	12		-.626				
	Originality	13					-.803	
	Flexibility	14					.484	
Stories:	Originality	15			-.466		-.406	
	Interest	16						
	Combined	17		-.732		.692		

TABLE 6

ROTATED FACTOR LOADINGS OF TORRANCE-ROGGE TESTS OF CREATIVITY
GRADE 12, N=149

Circles:	Fluency	1	.900					
	Originality	2	.918					
	Elaborateness	3	.838					
	Flexibility	4		-.609				
Tom:	Fluency	5			.689			
	Originality	6						
	Elaborateness	7						.736
	Flexibility	8	.585					
Toy Dog:	Fluency	9		.507				
	Originality	10				.609		
	Flexibility	11	-.658					
Tin Cans:	Fluency	12	-.697					
	Originality	13					.828	
	Flexibility	14	-.469					
Stories:	Originality	15						.597
	Interest	16				-.818		
	Combined	17			-.632			

The following picture emerges from the results of the factor analysis.

1. The separate scores reported for each subtest apparently do not represent separate aspects of creativity operating independently of subtest content. Only vary rarely did corresponding scores (e.g., flexibility) on different subtests load on the same common factor and in one of these occurrences (e.g., Factor II, Grade 12) flexibility loadings from two subtests were in opposite directions.

2. Common factors associated with the various subtests appeared to characterize the specific content of subtests rather than generalizable aspects of creativity. For example, at all levels, three or four scores from a single subtest identified the first factor. In grades 7, 10, and 12, this effect was less evident after the first factor.

3. Subtest performances at the five grade levels differed with respect to number and organization of common factors. No clear-cut trend of change in number or organization of factors at successive grade levels was apparent.

4. Although performances were characterized by different factorial structures at various levels, the Circles subtest made the most substantial contribution to significant factors at all grade levels.

Because of these findings, because it was considered desirable to establish norms for the same test or set of tests at all grade levels, and because results of the Circles test were available at the lowest cost, norms were compiled only for the Circles test. These scores then served as a stratification variable for maintaining statistical control of subject variation in creativity in treatment and control groups.

LOCAL NORMS: CIRCLES TEST

(Rogge Adaptation of Minnesota Tests of Creative Thinking)

Kindergarten

Raw Score Range	f	PR	Stanine
90-92	1	98	8
87-89	2	92	8
84-86	0	89	8
81-83	0	89	8
78-80	2	85	7
75-77	1	80	7
72-74	1	76	7
69-71	1	73	7
66-68	0	71	6
63-65	2	67	6
60-62	1	62	6
57-59	0	60	5
54-56	2	57	5
51-53	3	48	5
48-50	2	39	5
45-57	1	33	4
42-44	2	28	4
39-41	0	25	4
36-38	0	25	4
33-35	0	25	3
30-32	1	23	3
27-29	2	17	3
24-26	1	12	3
21-23	0	10	2
18-20	1	8	2
15-17	0	7	2
12-14	1	5	2
9-11	0	3	1
6-8	1	1	1

N = 28
M = 52.61
S = 22.66

Third Grade

Raw Score Range	f	PR	Stanine
123-125	1	96	9
120-122	0	95	9
117-119	0	95	9
114-116	0	95	9
111-113	0	95	9
180-110	4	91	8
105-107	1	86	8
102-104	1	84	8
99-101	0	83	7
96-98	2	81	7
93-95	1	78	7
90-92	3	73	6
87-89	0	70	6
84-86	4	66	6
81-83	3	59	6
78-80	4	52	5
75-77	2	45	5
72-74	1	42	5
69-71	3	38	4
66-68	0	35	4
63-65	2	33	4
60-62	3	28	3
57-59	4	20	3
54-56	2	14	3
51-55	1	11	3
48-50	2	8	2
45-47	2	4	2
42-44	1	1	2

N = 48
M = 76.40
S = 19.80

Seventh Grade

Raw Score Range	f	PR	Stanine
201-205	1	99	9
196-200	0	98	9
191-195	0	98	9
186-190	0	98	9
181-185	0	98	9
176-180	3	96	9
171-175	0	93	9
166-170	0	93	9
161-165	0	93	8
156-160	2	92	8
151-155	1	90	8
145-150	2	87	8
141-145	1	85	7
136-140	2	83	7
131-135	3	79	7
126-130	1	76	6
121-125	3	73	6
116-120	3	68	6
111-115	2	64	5
106-110	6	58	5
101-105	4	50	5
96-100	3	45	4
91-95	3	40	4
86-90	5	34	4
81-85	5	26	4
76-80	5	19	3
71-75	3	13	3
66-70	1	10	3
61-65	2	7	2
56-60	2	4	2
51-55	0	3	2
46-50	2	1	1

N = 65
M = 106.32
S = 33.04

Tenth Grade

Raw Score Range	f	PR	Stanine
141-145	2	99	9
136-140	1	98	9
131-135	0	97	9
126-130	0	07	9
121-125	3	96	9
116-120	4	94	8
111-115	4	91	8
106-110	1	89	8
101-105	6	86	7
96-100	9	81	7
91-95	4	76	6
86-90	6	72	6
81-85	9	67	6
76-80	12	59	5
71-75	9	51	5
66-60	11	44	5
61-65	10	36	4
56-60	12	28	4
51-55	8	21	3
46-50	9	15	3
41-45	3	10	3
36-40	8	6	2
31-35	1	3	2
26-30	1	2	2
21-25	1	1	1
16-20	0	1	1
11-15	0	1	1
6-10	0	1	1
1-5	2	0	1

N = 136
M = 73.65
S = 26.15

Twelfth Grade

Raw Score Range	f	PR	Stanine
171-175	2	99	9
166-170	2	98	9
161-165	0	97	8
156-160	3	96	8
151-155	0	95	8
146-150	1	95	8
141-145	2	94	7
136-140	7	91	7
131-135	1	88	7
126-130	1	87	6
121-125	5	86	6
116-120	6	82	6
111-115	6	78	5
106-110	3	75	5
101-105	13	70	5
96-100	13	62	4
91-95	7	55	4
86-90	9	50	4
81-85	10	44	4
76-80	8	38	3
71-75	7	33	3
66-70	10	27	3
61-65	7	22	2
56-60	11	16	2
51-55	5	11	2
46-50	6	7	1
41-45	3	4	1
36-40	3	2	1
31-35	0	1	1
26-30	2	1	1
21-25	0	<1	1
16-20	1	<1	1

N = 154
M = 89.41
S = 31.83

APPENDIX C

DEVELOPMENT OF PUPIL BEHAVIOR OPINION SURVEY*

One of the original aims of the project was to ascertain whether or not a given training program would produce changes in the attitudes of teacher trainees toward pupil behavior associated with creativity. One basis of assessing attitudes is to determine the evaluative connotation of concepts, objects, events, persons, etc., which are potential targets for attitudes, using the Semantic Differential Technique.

The Semantic Differential Technique is a byproduct of the psycholinguistic studies of Osgood, Suci, and Tannenbaum (1957). In an effort to determine common aspects of connotative meaning, Osgood and his associates constructed a set of 76 scales whose content was identified by bipolar adjective pairs. The bipolar pairs were determined in a two-stage process: (1) a pool of commonly used adjectives was identified by asking people to name an adjective which they would use to describe one of a large number of nouns from the Kent-Rosanoff word list; and (2) pairing each adjective appearing with sufficiently large frequency (named by at least 5% of the sample) with an antonym selected from Roget's Thesaurus, 1951 edition. The selected pool of 76 scales was then used to rate a selected list of 20 concepts. Correlations between pairs of scales were computed, summing across concepts and subjects; and the qualification structure of the pool of adjective pairs was determined by centroid factor analysis of the resulting matrix of intercorrelations. The resulting factor structure identified three aspects of connotative meaning characterizing the 76 adjective pairs, identified as Evaluation, Dynamism, Stability, and Warmth.

Osgood suggested the use of the semantic differential technique as a basis for assessing attitudes and offered evidence that use of this technique produces results which are highly correlated with attitude assessments obtained by other techniques, e.g., Thurstone scales. The basis of the use of the Semantic

*Appendix C was written by Robert Rumery, project evaluation consultant.

Differential Technique for attitude measurement is to obtain ratings of objects toward which attitudes are to be assessed using scales with dominant factor loadings on the evaluative factor. He suggested that it might sometimes be advisable to embed evaluative scales in a set of nonevaluative scales.

In this project, the objects toward which attitudes were to be assessed were descriptions of student behavior which were interpreted as related to creativity and descriptions of student behavior which could be characterized as convergent, non-critical, or conforming behavior. Ten descriptions were characterized as creativity and the ten were characterized as convergent, non-critical, or conforming. In a pilot sample of teacher trainees not involved in the project, ratings of these 20 "concepts" were obtained using five evaluative scales: beneficial-harmful, superior-inferior, successful-unsuccessful, meaningful-meaningless, valuable-worthless. Analysis of data from this pilot group revealed significant interaction between concept and scale and quite high internal consistency of ratings of both "positive" and "negative" concepts. For the final form of the attitude survey, two principal changes were made in the structure of the survey. First, four concepts were eliminated for one of three reasons: the concepts were substantially implicated in concept by scale interaction; the content of the concept appeared to be only moderately related, either positively or negatively, to conceptions of creativity consistent with the aims of the project; or the ratings of positive concepts were not substantially different from ratings of their negative counterparts. Second, in the final form, each positive concept was paired on the same page of the survey with a negative concept differing in content but approximately equivalent in its favorability as indicated by ratings in the pilot group. Third, in the revised form, scales were alternately directed toward positive and negative ratings; that is, for any concept, the scale beneficial-harmful or harmful-beneficial was followed by inferior-superior or superior-inferior. In scoring the survey, scale values ranged from 1 indicating

negative valuation to 7 indicating positive valuation.*

*See Appendices G and I for an analysis of the results using this instrument.

PUPIL BEHAVIOR OPINION SURVEY

(Date) _____ (Name) _____

Robert E. Rumery
Illinois State University

The purpose of this survey is to determine the meanings of several kinds of hypothetical pupil classroom behavior to different people. On the pages that follow are sixteen statements describing aspects of classroom behavior of hypothetical pupils which you are to judge against a series of descriptive scales. On each page of the booklet you will find two descriptions of behavior with a set of five scales underneath each statement. You are to rate the behavior represented in each statement on each of the five scales below it.

Here is how to use the scales:

If you feel that the pupil behavior described above the set of scales is very closely related to one end of the scale, you should place your check-mark as follows:

beneficial X :___:___:___:___:___:___harmful

or

beneficial___:___:___:___:___:___: X harmful

If you feel that the pupil behavior described is quite closely related to one or the other end of the scale (but not extremely), you should check as follows:

superior___: X :___:___:___:___:___inferior

or

superior___:___:___:___:___: X :___inferior

The direction toward which you check depends upon which of the two ends of the scale seem most characteristic of the behavior you are judging.

If you consider the pupil behavior described to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, then you should check the middle space:

successful___:___:___: X :___:___:___unsuccessful

Please make your judgments on the basis of what the described pupil behaviors mean to you. In marking the scales, be sure to:
(1) place your marks in the middle of spaces, not on the boundaries;
(2) check every scale for every description of behavior; and
(3) make only one mark on a single scale.

1. Responds to questions with unconventional answers

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

2. Shifts to an easier problem when efforts to solve a difficult problem are frustrated

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

3. Sometimes chooses projects or activities primarily of interest to students of opposite sex

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

4. Actively avoids sex-inappropriate projects and activities

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

5. Continues to work on difficult problems after repeated failure to arrive at an acceptable solution

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

6. Relies on authority or convention for definition of terms or concepts

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

7. Attempts unusual solutions to problems when probability of successful solution is slight

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

8. In area of ambiguity or controversy, accepts opinions or conclusions of teacher or other authoritative source

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

9. Questions assertions other students accept on the authority of their source

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

10. Responds to questions with quotations or paraphrases from authoritative sources

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

11. Defines terms or concepts in several ways, differing from those supplied in common resource materials

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

12. Terminates work on a problem when an acceptable solution has been achieved

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

13. Persists in work on problems when solutions acceptable to most students have been reached

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

14. Concentrates on problems and activities assigned by teacher

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

15. Persists in a point-of-view against strong opposition if evidence supports his opinion

harmful___:___:___:___:___:___:___beneficial

superior___:___:___:___:___:___:___inferior

unsuccessful___:___:___:___:___:___:___successful

meaningful___:___:___:___:___:___:___meaningless

worthless___:___:___:___:___:___:___valuable

16. Selects problem-solving strategies with highest probabilities of yielding acceptable solutions

beneficial___:___:___:___:___:___:___harmful

inferior___:___:___:___:___:___:___superior

successful___:___:___:___:___:___:___unsuccessful

meaningless___:___:___:___:___:___:___meaningful

valuable___:___:___:___:___:___:___worthless

APPENDIX D

DESCRIPTION OF EXPANDED INTERACTION ANALYSIS CATEGORY SYSTEM*

There have been a number of category systems for analyzing verbal interaction in the classroom. Perhaps the best known of these has been the Interaction Analysis system with its ten categories for analyzing verbal behavior. The category system utilized in this project is a modification of the Interaction Analysis system in which each of the ten categories is divided into subcategories for study in greater detail. The Expanded Interaction Analysis category system was originally presented by Edmund J. Amidon to the American Education Research Association Convention in Chicago in 1966. In the Expanded Interaction Analysis system each category is broken down into two to four subcategories that are used to examine the behaviors that fall into each individual category in greater depth and detail. Differences in the ways in which various statements in the same category function in classroom interaction are studied with the expanded system.

The subcategories that have been developed for the Exapnded Interaction Analysis system have come out of attempts to integrate some of the work of Marie Hughes, Hilda Taba, and James Gallagher and Mary Jane Aschner with work done in Interaction Analysis at Temple University in the last few years. Because the category system is expanded through the use of subcategories rather than new categories, data collected in the Expanded Interaction Analysis category system are comparable to all data collected under the basic Interaction Analysis system, but the subcategories enable the teacher to examine certain behaviors in greater detail. An explanation of the subcategories follows:

Category 1--Accepts Student Feelings

1a--Acknowledges feelings. The teacher simply acknowledges the presence of some feeling in the classroom; she may identify the feeling by name.

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*Adapted from SKIT WORK MANUAL by Amidon and Rosenshine (1969)
(See Appendix G for analysis of reliability of the observational process)

1c--Clarifies feelings. The teacher attempts to relate the feeling he observes to a probable cause.

1r--Refers to similar feelings of others. The teacher indicates that the feeling he observes is natural or normal by referring to similar feelings that he has, or that people in general have, in like circumstances.

Category 2--Praises

2w--Praises with no criteria. The teacher tells the student he is right or that what he has done is good, but gives no reason for the positive evaluation.

2P--Praises with public criteria. The teacher praises the student and gives a reason for the positive evaluation that is publicly verifiable and acceptable. An accepted authority, like the dictionary, may be used as the criterion for evaluating factual matters.

2p--Praises with private criteria. The teacher praises the student and explains that the praise is based on her private (nonauthoritative) standards or opinions. Statements in this subcategory communicate the teacher's preferences.

Category 3--Accepts Student Ideas

3a--Acknowledges ideas. The teacher acknowledges a student contribution by simple reflection or a word such as "okay." No evaluation of the student's contribution is included in statements in this subcategory.

3c--Clarifies ideas. The teacher goes beyond simple acknowledgment of the student's contribution by restating the student's idea or speculating on its implications.

3s--Summarizes ideas. The teacher acknowledges contributions of several students by enumerating them or organizing them into a coherent sequence.

Category 4--Asks Questions

4f--Asks factual questions. The teacher asks for a simple factual response. Questions in this category require recall rather than problem-solving

or opinion giving.

4c--Asks convergent questions. The teacher asks the student to compare or contrast, to relate two or more things in a significant manner, or to follow some formal procedure for solving problems, such as a mathematical formula.

4d--Asks divergent questions. The teacher asks the child to predict, to develop hypotheses, or to speculate on outcomes of actions in a hypothetical situation that does not permit evaluation of student responses as right or wrong.

4e--Asks evaluative questions. The teacher asks students for their evaluation of an idea or an event as better or worse, more or less appropriate, and the like. Evaluation of student response as right or wrong is precluded by the nature of the question.

Category 5--Lectures

5f--Factual lecture. The teacher communicates factual information or subject-matter content.

5m--Motivational lecture. The teacher attempts to communicate enthusiasm or excitement about subject matter to children or in some other way arouse interest through the use of lecture statements.

5o--Orientation lecture. The teacher describes the procedure for approaching subject matter or presents some framework for what the class has been doing or will do.

5p--Personal opinion lecture. The teacher provides personal opinions or evaluations of ideas or procedures.

Category 6--Gives Directions

6c--Gives cognitive directions. The teacher asks children to do a task primarily cognitive rather than overtly physical, such as writing the answer to a problem on the board.

6m--Gives managerial directions. The teacher directs the student or students to perform a physical maneuver, such as moving chairs.

Category 7--Criticizes

7w--Criticizes with no criteria. The teacher criticizes with no explanation of the reason for the criticism.

7P--Criticizes with public criteria. The teacher criticizes a student and explains the criticism in terms of public standards for evaluation.

7p--Criticizes with private criteria. The teacher criticizes a student and explains the criticism in terms of his personal preferences or aversions.

Category 8--Predictable Student Talk

8f--Factual student talk. The student gives factual information, usually in response to a teacher question classified as 4f.

8c--Convergent student talk. The student makes a statement involving use of facts in a specified process, such as following a formula or contrasting events, usually in response to a teacher question classified as 4c.

Category 9--Unpredictable Student Talk

9d--Divergent student response. The student speculates or hypothesizes on how things might be (or might have been) under given circumstances, usually in response to a teacher question classified as 4d.

9e--Evaluative student response. The student gives his evaluation of an idea or event as better or worse, more or less appropriate, etc., usually in response to a teacher question classified as 4e.

9i--Student-initiated talk. The student makes an unsolicited comment.

Category 10--Silence or Confusion**

10s--Silence. There is a period of at least three seconds in which no one is talking.

**Note: Category 10, without a subcategory letter, has a conventional use. All coding sequences begin and end with 10, so that a summary matrix prepared from the raw data will balance. It is also used to indicate a change of student when one student interrupts another student who is talking.

10c--Confusion. There is a period of at least three seconds in which more than one person is talking and it is not possible to hear what a single person is saying.

EXPANDED INTERACTION ANALYSIS CATEGORY SYSTEM

TEACHER TALK

1. ACCEPTS STUDENT FEELINGS
   - 1a--Acknowledges feelings.
   - 1c--Clarifies feelings.
   - 1r--Refers to similar feelings of others

2. PRAISES
   - 2w--Without criteria
   - 2P--With public criteria
   - 2p--With private criteria

3. ACCEPTS STUDENT IDEAS
   - 3a--Acknowledges ideas.
   - 3c--Clarifies ideas.
   - 3s--Summarizes ideas.

4. ASKS QUESTIONS
   - 4f--Factual questions
   - 4c--Convergent questions
   - 4d--Divergent questions
   - 4e--Evaluative questions

5. LECTURES
   - 5f--Factual lecture
   - 5m--Motivational lecture
   - 5o--Orientational lecture
   - 5p--Personal opinion lecture

6. GIVES DIRECTIONS
   - 6c--Cognitive directions
   - 6m--Managerial directions

7. CRITICIZES
   - 7w--Without criteria
   - 7P--With public criteria
   - 7p--With private criteria

STUDENT TALK

8. STUDENT TALK, PREDICTABLE
   - 8f--Factual student talk
   - 8c--Convergent student talk

9. STUDENT TALK, UNPREDICTABLE
   - 9d--Divergent student talk
   - 9e--Evaluative student talk
   - 9i--Student-initiated talk

NO TALK

10. SILENCE OR CONFUSION
    - 10s--Silence
    - 10c--Confusion
    - 10---Without a subcategory letter indicates:
      A change of speakers in student-to-student interaction, and the beginning and end of a coding sequence in matrix construction.

APPENDIX E

GUIDELINES FOR IDENTIFYING HYPOTHESES

The following guidelines were developed specifically for use in the project research and the training programs. They were utilized by project research assistants in analyzing video-tapes and by trainees in evaluating their teaching performance. See Appendix G for an analysis of the reliability of the observation process.

A. Hypothesis defined: A hypothesis is a divergent-type idea statement which posits a plausible solution (complete or partial) for a given problem. Such statements either make explicit or imply an if-then relation, such as: "If such-and-such, Then the problem will be solved (completely or in part).*

B. Goal and exclusions: The goal is to identify original hypotheses (solutions) posited by pupils. Hypotheses which are highly conventional or commonly known (or accepted) solutions should not be counted. (This, of course, is a matter of judgment on the part of the observer).

C. Inclusions: A divergent-type idea statement should be counted as a hypothesis under any of the following circumstances:

1. If it posits a complete solution to the problem under consideration.

2. If it posits a single element (or part) of the solution to the problem under consideration.

3. If it posits several elements (or parts) of the solution to the problem under consideration.

4. If it consists of adding a new element to a hypothesis already given.

5. If it consists of adding several new elements to a hypothesis already given.

D. Hypotheses and the DOM: All of the cells of the Divergent Operations Matrix (DOM) are probably related to the generation of plausible hypotheses. However, discussions of causes, consequences, relationships, predictions, or particular elements of the problem are not hypotheses per se. Only when divergent-type ideas brought up in such discussions are stated as possible solutions to the problem under consideration are they to be considered hypotheses.

E. Summary: THUS, FOR THE PURPOSES OF THIS TRAINING PROGRAM, DIVERGENT-TYPE IDEA RESPONSES OF PUPILS ARE TO BE COUNTED AS HYPOTHESES ONLY WHEN THEY CONFORM TO THE VARIOUS SPECIFICATIONS ENUMERATED IN A, B, C, AND D ABOVE!

*Definition of Divergent Production: Generation of information from given information, where the emphasis is upon variety and quantity of output from the same source; a search for logical alternatives. (Guilford, 1969).

APPENDIX F

NONMETRIC MULTIDIMENSIONAL SCALING OF CLASSROOM INTERACTION PATTERNS OBTAINED WITH THE EXPANDED INTERACTION ANALYSIS CATEGORY SYSTEM* (NO-TRAINING AND FIRST TRAINING GROUPS)

An adaptation of the Amidon-Rosenshine Expanded Interaction Analysis Category System was used as a basis for obtaining representations of classroom climate. Eight categories of behavior were selected for attention: Teacher praises pupils; teacher accepts pupils' ideas; teacher asks factual questions; teacher asks divergent questions; teacher asks evaluative questions; teacher criticizes pupils; pupil gives factual response; pupil gives divergent response; pupil gives evaluative response. Videotapes of microteaching sessions (No-Training Group and First Training Group) were coded using the usual procedure of categorizing behavior in three-second intervals. Binary sequences were then entered in an interaction matrix. An entry in cell ij of the interaction matrix indicates the number of times behavior in category i, represented by row i in the matrix is followed by behavior in category j, represented by column j in the matrix.

In conventional use, classroom climate measures are given by specified row or column sums, or derived from operations on combinations of row and column sums. Two objections can be seen to the use of these indices. First, they seem to have a somewhat arbitrary character. Second, the indices do not take advantage of the most significant information available in the interaction matrix--information about sequences of events. A multidimensional scaling procedure (Kruskal, 1964a, 1964b) was used to represent climate characteristics associated with patterns of binary sequences in the interaction matrices obtained for participants in the project.

The aim of multidimensional scaling is to obtain a representation of a set of points in an abstract space which preserves certain relations among observed or derived interpoint distances. In the application of multidimensional scaling to interaction matrices, the points in the abstract space correspond to the occurrence of events in each of the eight behavior categories selected for observation.

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*Appendix F was written by Robert Rumery, project evaluation consultant.

The interpoint distances are indices of dissimilarity between pairs of behavior categories. The axes of the abstract space represent attributes which discriminate behavior classified in the eight behavior categories.

The first problem in the use of multidimensional scaling for the purpose intended in this project was how to obtain indices of intercategory dissimilarity which could be used as estimates of interpoint distance. A set-distance function described by Hays (1958) and Restle (1959) was used as the basis for converting entries in the interaction matrix to estimates of interpoint distance. The method depends upon considering behavioral events classified in each of the eight behavior categories as elements of sets. The distance between two sets can be estimated on the basis of the number of elements in the two sets which are not common to both sets. The total number of behavioral events classified in a behavior category (that is, a row or column sum of the interaction matrix) is interpreted as the number of elements in a set. The total number of occurrences of binary sequences in which behavior in category i is followed by behavior in category j or behavior in category j is followed by behavior in category i is interpreted as the number of elements common to sets I and J. The distance between sets is represented by the total number of noncommon elements; that is, the distance between sets I and J is the difference between the total number of elements in the two sets and the number of elements common to both sets. Some simple examples will illustrate the procedure.

Consider three categories of behavior which occur in sequences summarized in the following interaction matrix. A total of 45 behavioral events were classified in category 1, 45 in category 2, and 50 in category 3. Events in category 1 were followed by events in category 2 15 times and by events in category 3 20 times. Events in category 2 were followed by events in category 1 20 times and by events in category 3 15 times. Events in categories 1 and 2 are followed by events in the same category 10 times each. The distance between sets 1 and 2 is found

	1	2	3	
1	10	15	20	45
2	20	10	15	45
3	15	20	15	45
	45	45	50	

by finding the total number of events in category 1 not followed by events in category 2 and the number of events in category 2 not followed by events in category 1. In this example, the distance between sets 1 and 2 is 45 + 45 - 15 - 15 = 60.

Another example illustrates a case in which the distance between sets 1 and 2 is zero. In this example, the distance between sets 1 and 3 is 25 and the

	1	2	3	
1	0	25	0	25
2	25	0	0	25
3	0	0	25	25
	25	25	25	

distance between sets 2 and 3 is 50. It can be seen that the distance between any two categories is a function of the joint occurrence of events (occurrence in sequence) of events in two classes and of the total number of occurrences (weights) of the two classes.

The interpoint distances obtained by this method are input data for the multidimensional scaling procedure. The basis of the procedure and an outline of computational methods involved may be found in the two articles by Kruskal. The second of the two articles indicates guidelines for determining the appropriate number of dimensions in which points are to be represented. The technique produces a configuration of points which preserves the order of interpoint distances in the input data.

Individual configurations were obtained for each participant. In most cases, two dimensions adequately represented obtained interpoint distances. In some of the remaining cases, three dimensions were required to represent the points; in others, one dimension was sufficient. In all cases the meaning of the dimensions was inferred from the content of behavior categories having extreme projections on axes of the abstract spaces. Configurations of individual interactions were substantially unique. Intersubject comparisons were not attempted for two reasons: first, because distances were estimated in the absence of a standard unit of measurement; second, because no statistical or numerical methods are yet available for comparing configurations produced by this technique.

Although the configurations obtained were substantially unique, two features were shared by a substantial portion of the configurations. The first was the appearance of a dimension on which divergent questions and divergent responses were contrasted with evaluative questions by the teacher and/or evaluative responses by pupils. In some cases, the contrast included factual questions and responses in close proximity to evaluative behavior. A second feature was that, in general, the occurrence of divergent responses was unrelated to the occurrence of classes of behavior identified as Teacher Indirect Influence: praise, acceptance, and criticism. The results of these analyses were used in subsequent development of training programs.

UNTRAINED

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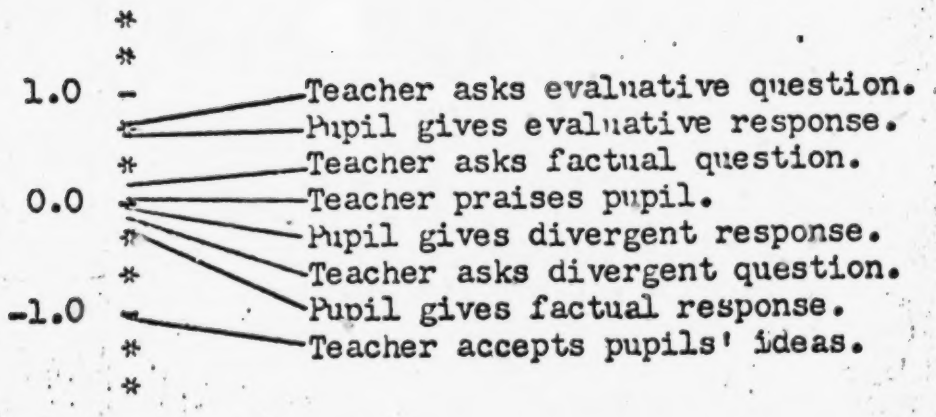

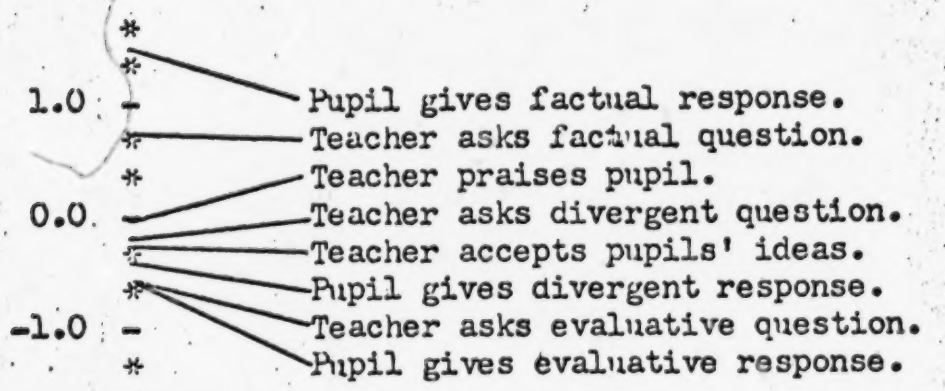

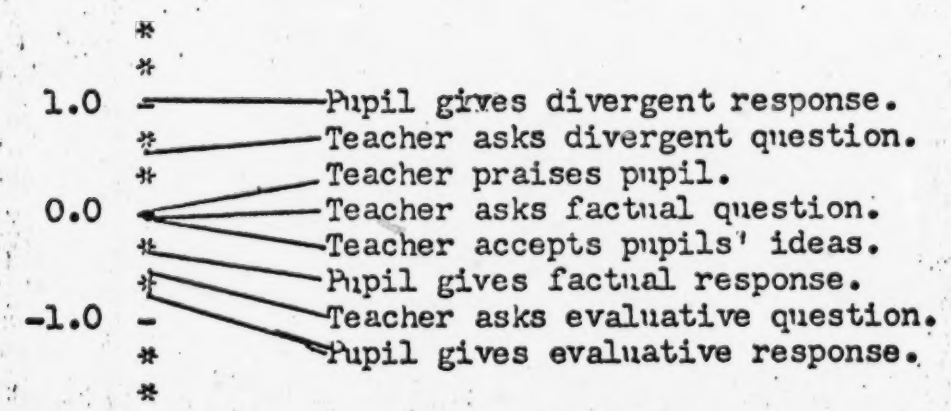

NOTE:

Scales--Different scales (or continua) represent different dimensions
Frequency--Frequency of occurrence of behaviors is indicated by distances (either positive or negative) from 0
Relationships--Sequential relationships between behaviors are indicated by proximity of one to another on the scale.

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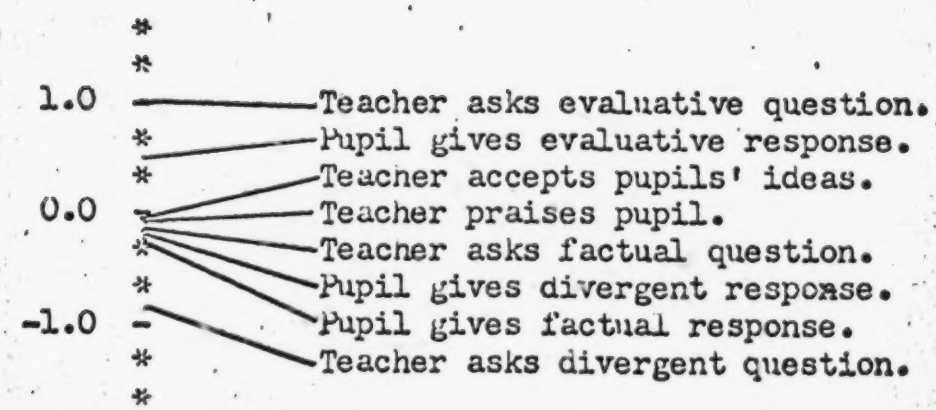
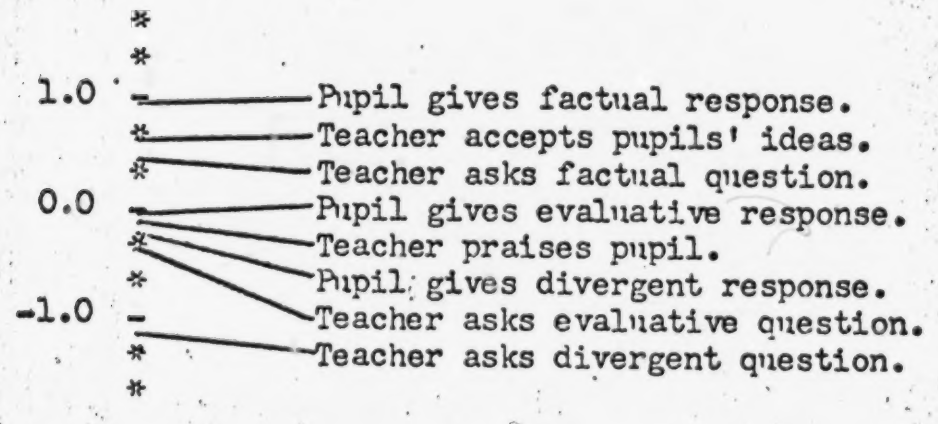
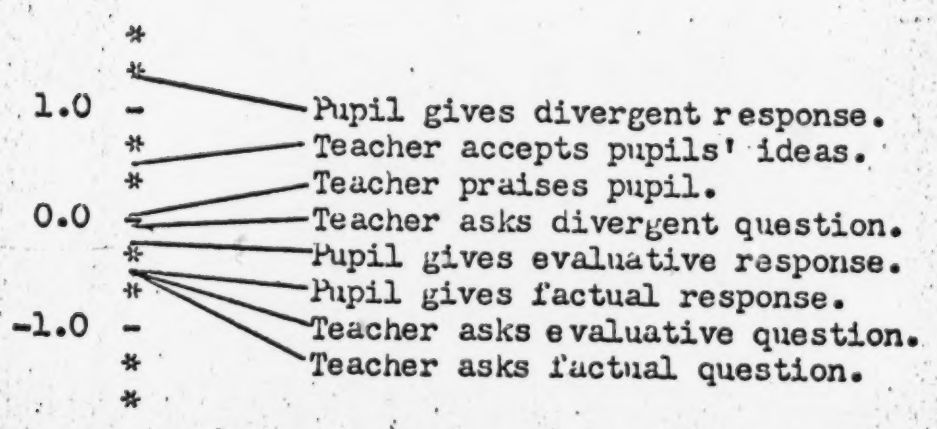
ANDERSON







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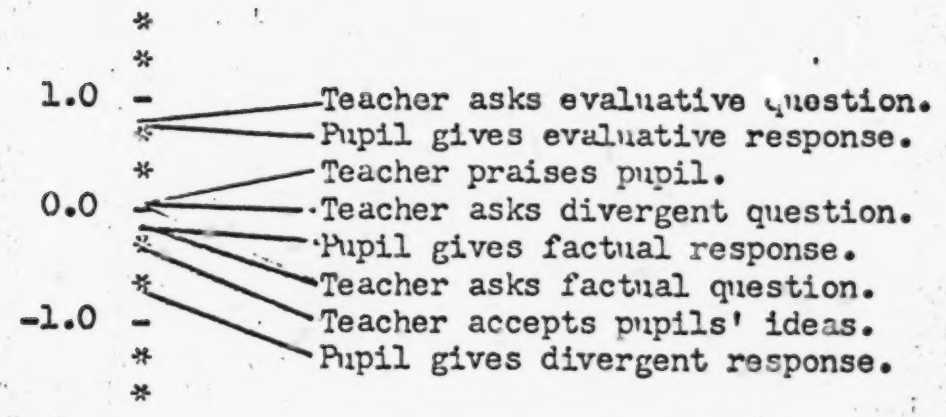

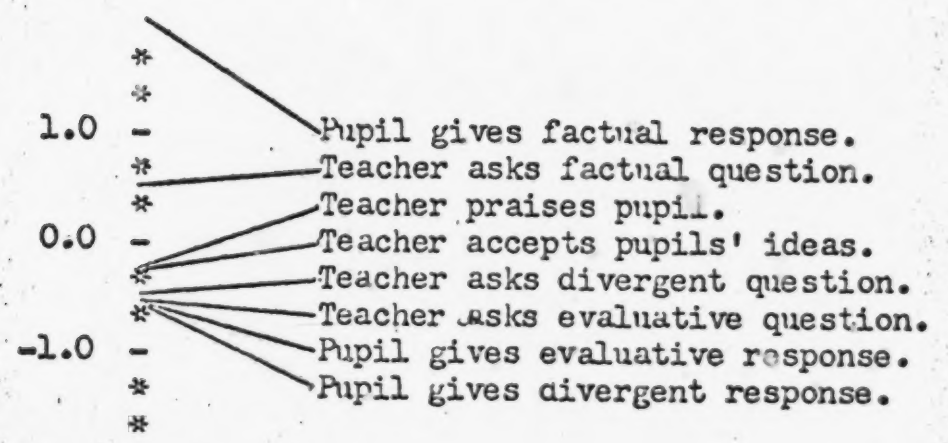

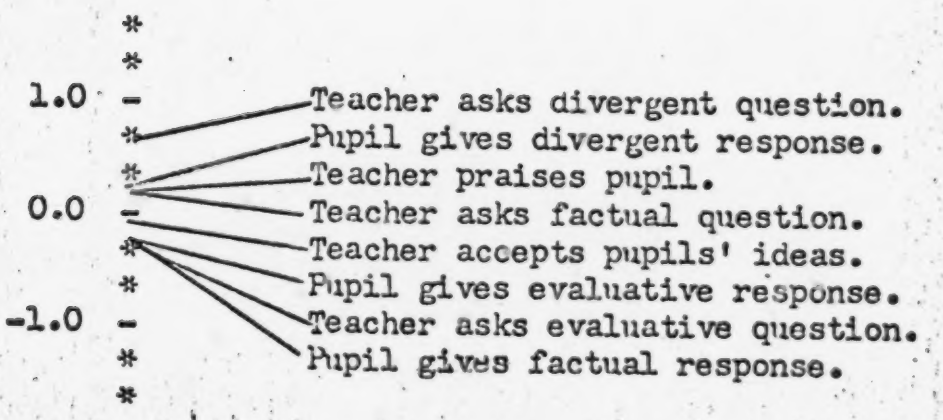

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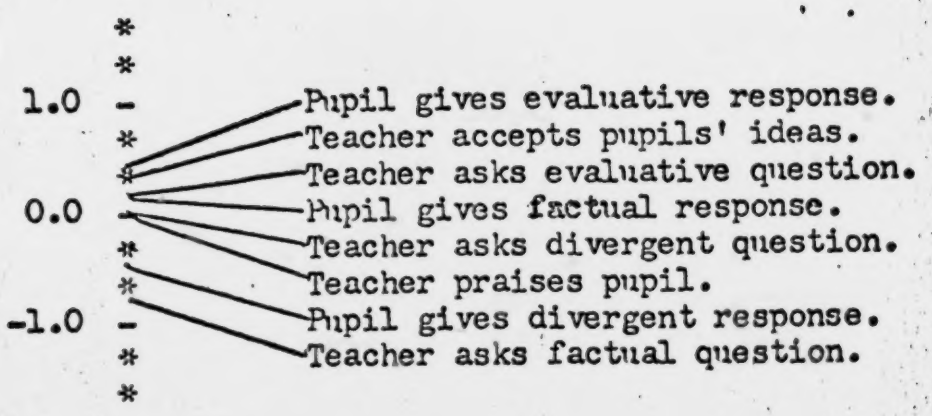

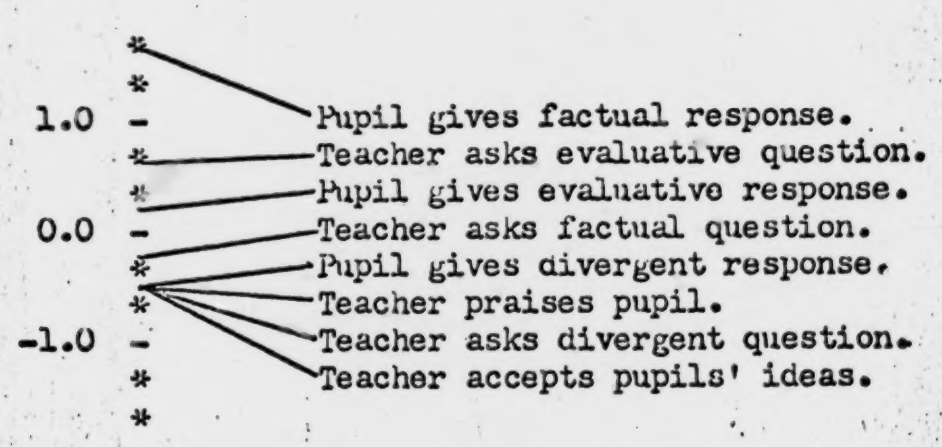

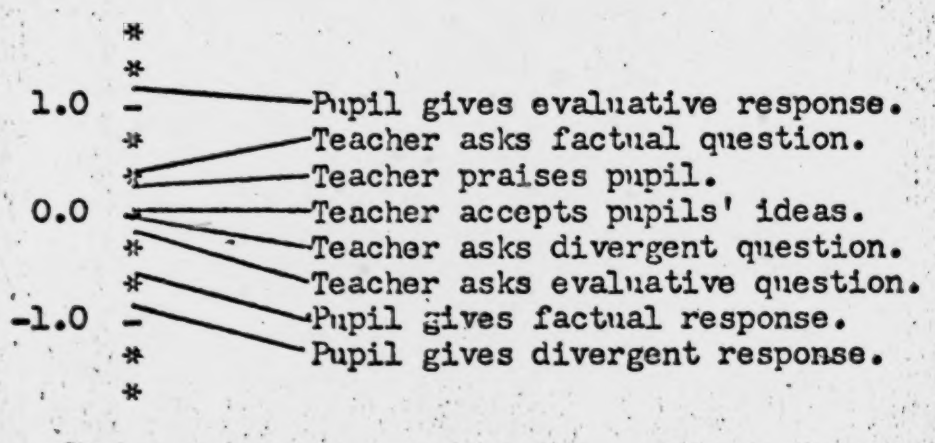

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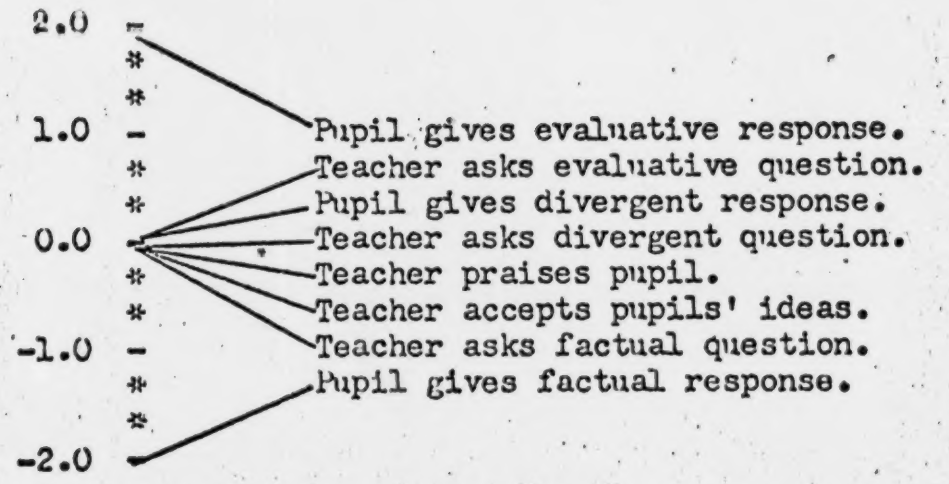

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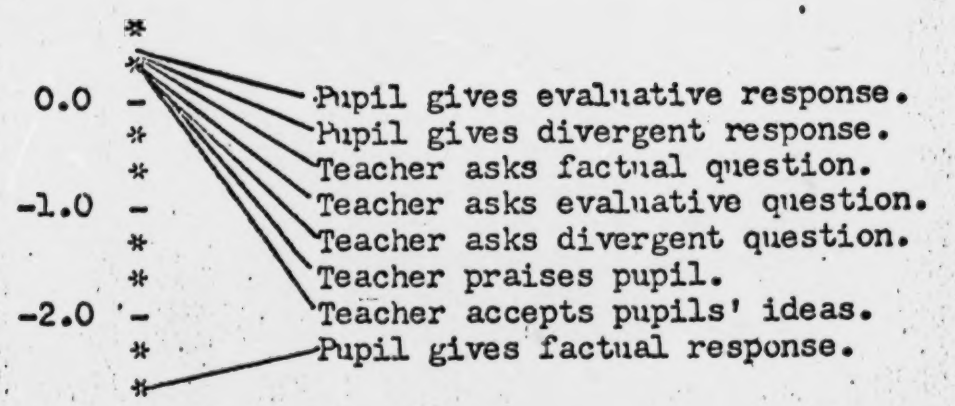

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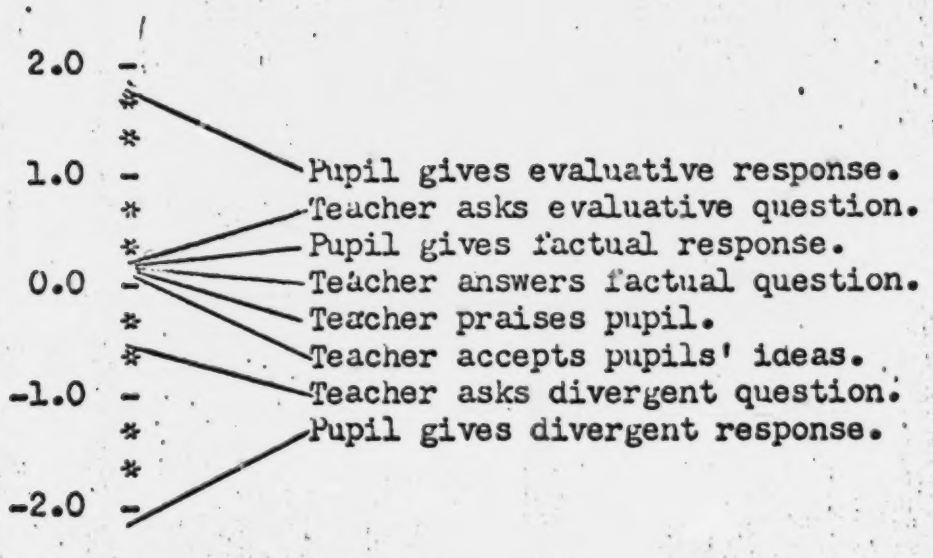

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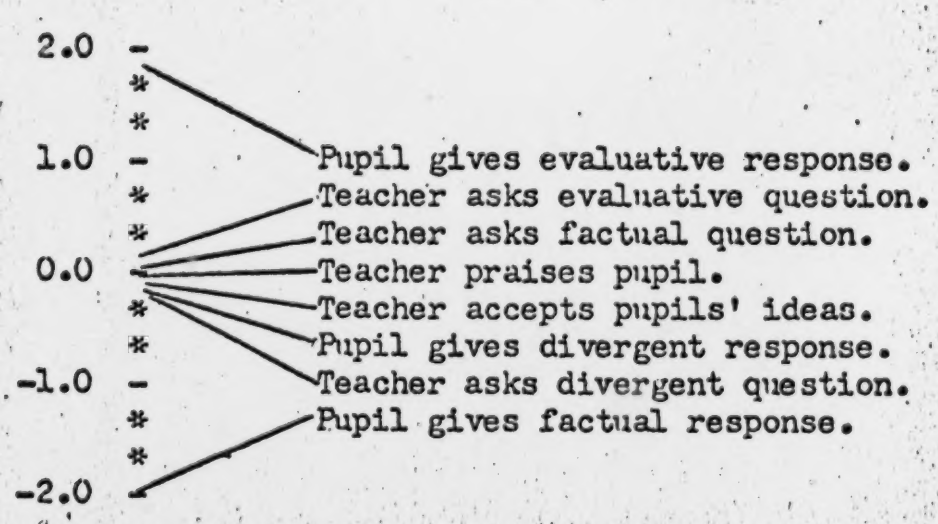

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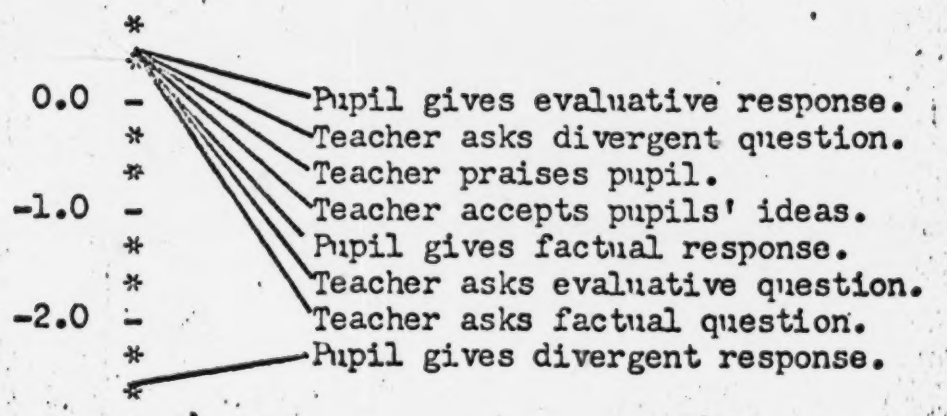

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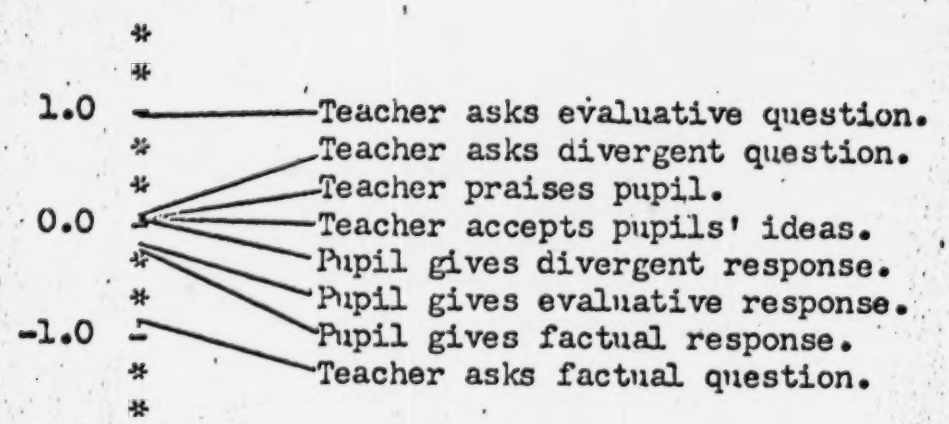

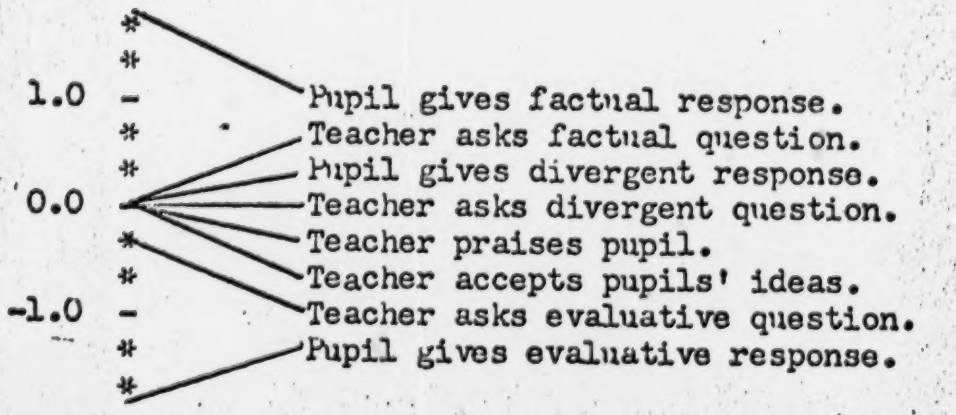

TRAINED

FAIKUS

```
        *
        *
1.0     -       Pupil gives factual response.
        *       Teacher asks factual question.
        *       Teacher asks evaluative question.
0.0     -       Pupil gives evaluative response.
        *       Teacher praises pupil.
        *       Teacher accepts pupils' ideas.
-1.0    -       Teacher asks divergent question.
        *       Pupil gives divergent response.
        *
```

```
        *
        *
0.0     -       Teacher accepts pupils' ideas.
        *       Pupil gives factual response.
        *       Pupil gives divergent response.
-1.0    -       Pupil gives evaluative response.
        *       Teacher asks factual question.
        *       Teacher asks evaluative question.
-2.0    -       Teacher praises pupil.
        *       Teacher asks divergent question.
        *
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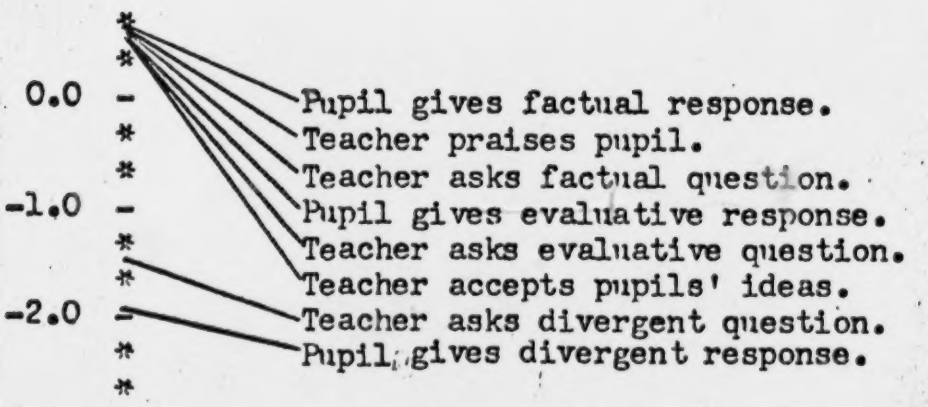
TRAINED

HAGENSICK



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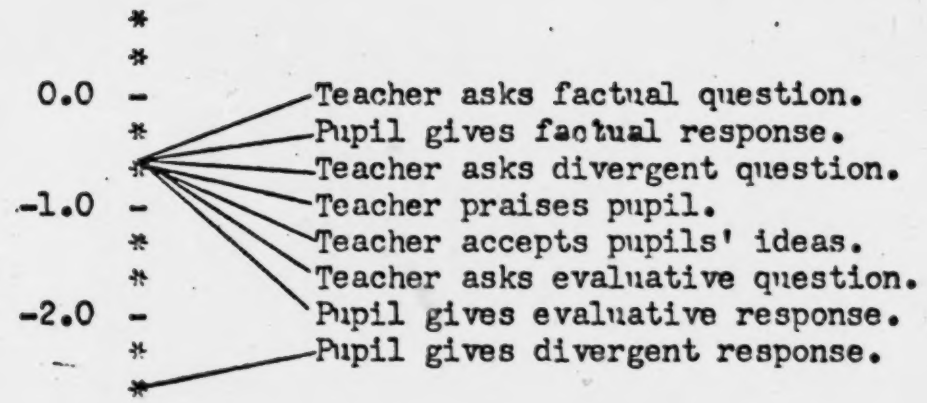

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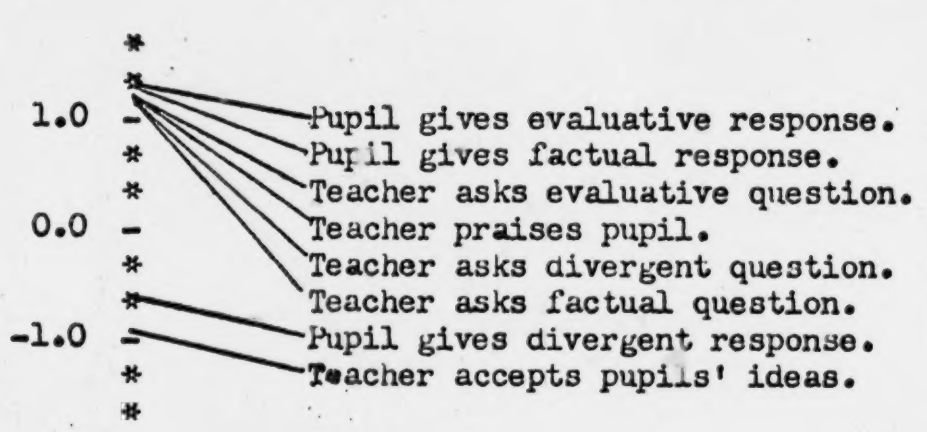

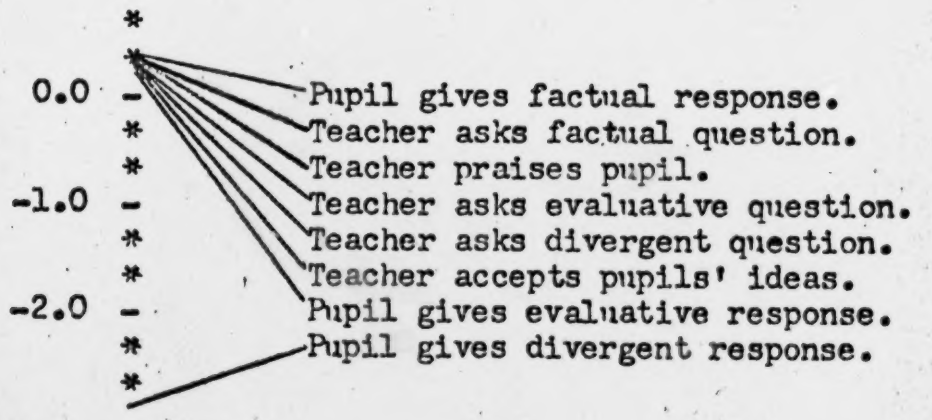

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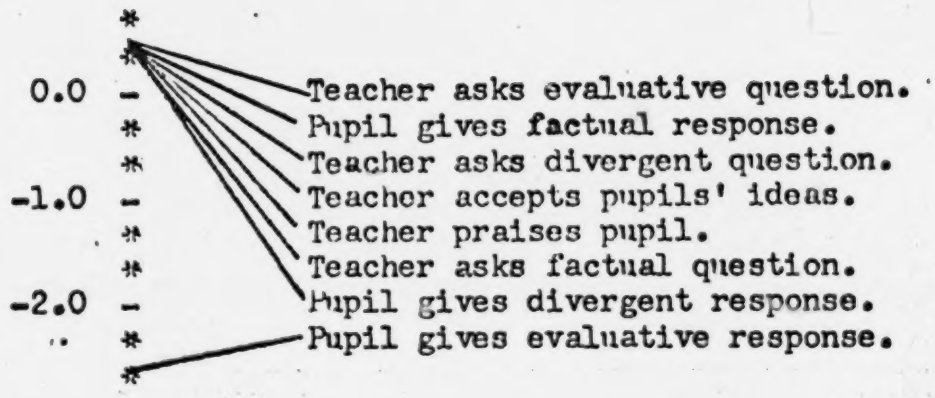

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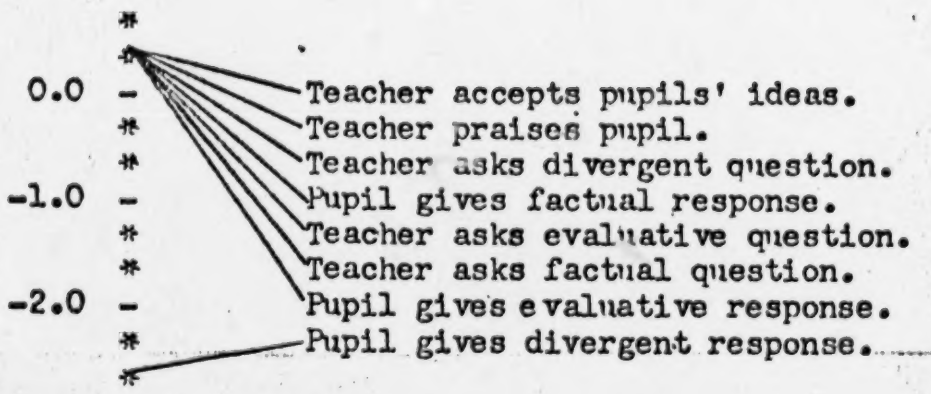

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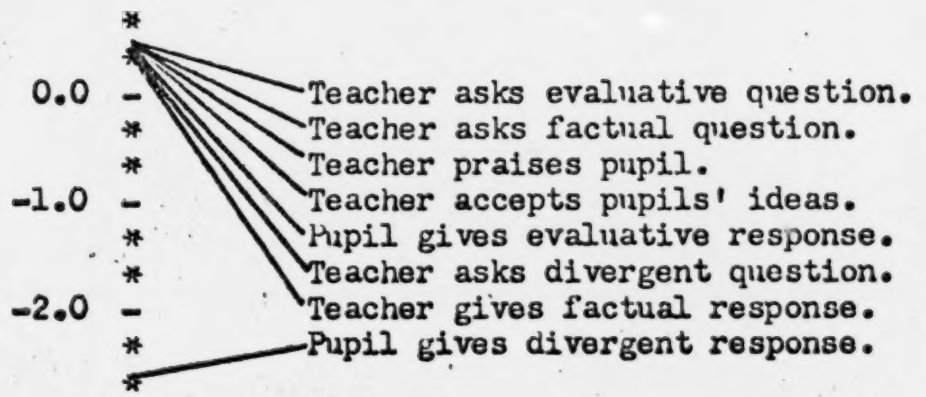

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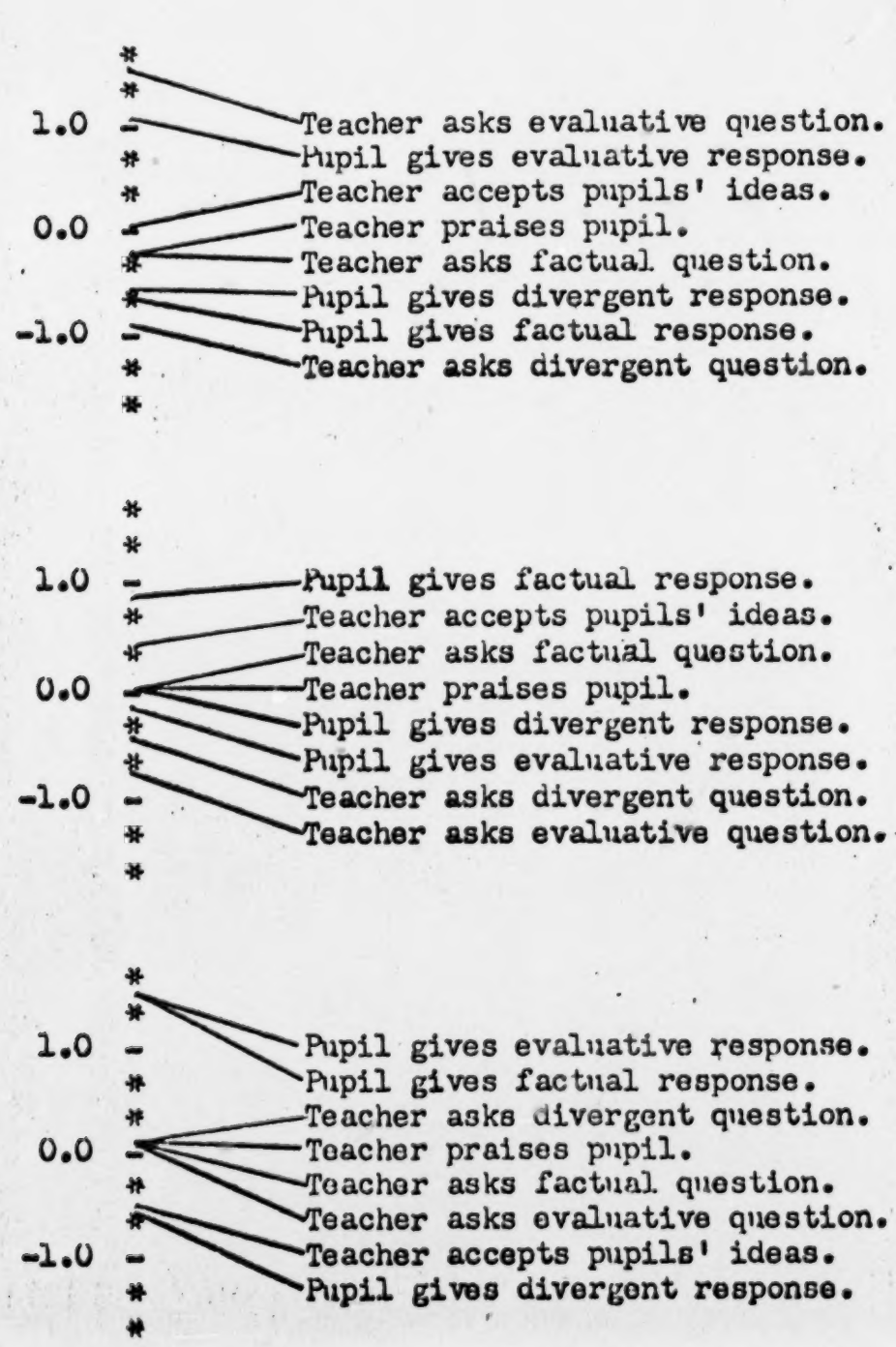

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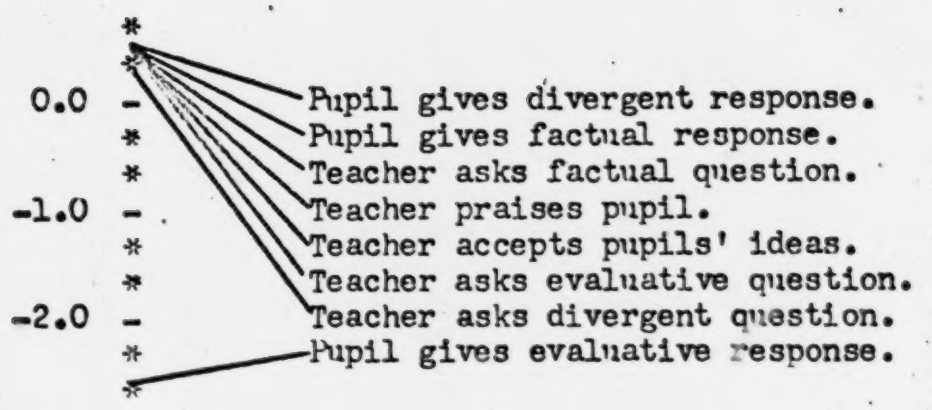

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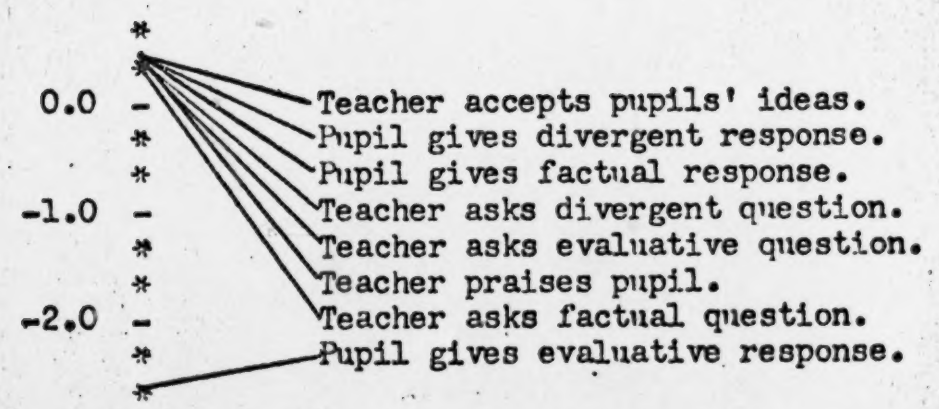


APPENDIX G

COMPARATIVE ANALYSIS OF NO-TRAINING, FIRST TRAINING, AND SECOND TRAINING PROGRAMS*

Introduction

The data analysis consists of a comparison of three groups of preservice teachers on each of several dimensions. The first group of 10 teachers received no training (NT). The second group of 10 teachers was exposed to the first training program (1 Tr) developed. This program was then revised and a third group of 10 teachers was trained under this modified program (2 Tr). To measure the effects of the training programs pupils were selected from those enrolled at the ISU laboratory schools in grades K, 3, 7, 10 and 12. Micro-groups of four to six pupils were formed on the basis of scores on the Creative Abilities Test (Rogge adaptation of the Torrance Test) in order to secure reasonably comparable groups along this dimension. Six such groups were formed at each grade level. Each one was involved in a single micro-teaching session taught by one teacher from either the No-Training, the First Training, or the Second Training group. The micro-teaching sessions were video-taped and these tapes provided the basic data for analysis. The sampling unit employed in the data analysis was the micro-group.

Description of Micro-Teaching Session

Each micro-teaching session was conducted in a modified classroom setting and involved from four to six laboratory school pupils with the trainee as instructor. The pupils did not have prior information regarding the content of the session, nor had they met the trainee before the session. The trainee was given the names of the pupils prior to the session. The session began when the trainee introduced himself to the group. Thereupon he posed the problem (or activity) to be considered and asked the micro-group to posit alternative solutions (hypotheses) for the problem. No time limits were imposed on the micro-sessions and they were not interrupted by the investigators. All sessions which involved the generation

*With the exception of the second paragraph Appendix G was written by Ronald Halinski, project evaluation consultant.

of hypotheses were video-taped for later analysis. (See portions of report dealing with selection of pupils, trainees, and development of training programs for further details on the micro-teaching sessions.)

Description of the Data Collected

For each micro-group the following data were obtained:

1. Grade level of the micro-group.
2. Treatment group of the preservice teacher.
3. Length of the session in minutes.
4. Number of hypotheses generated by the pupils in the micro-group. (These were tabulated independently by two trained observers for purposes of establishing the reliability of the observation process)
5. Number of intervals a behavior described in the Expanded Interaction Analysis Category System (EIACS) took place (See Appendix I). (These intervals were approximately 3 seconds in length.)
6. Number of intervals in which pupil talk, as described in EIACS, was recorded.
7. Number of intervals in which the pupil talk was divergent, as described in EIACS, was recorded.
8. Attitude of the preservice teacher, as measured by the Pupil Behavior Opinion Survey, prior to the treatment.
9. Attitude of the preservice teacher, as measured by the Pupil Behavior Opinion Survey, following the micro-teaching session.

In addition to the analysis of these data, several indices were developed as follows:

1. The number of hypotheses generated in a session divided by the length of the session in minutes. (Hyp/min)
2. The number of student divergent intervals divided by the number of pupil talk intervals. (St Div/St Talk)

Description of the Pupil Behavior Opinion Survey

One of the original aims of the project was to ascertain whether or not a given training program would produce changes in the attitudes of teacher trainees toward pupil behavior associated with creativity. One basis of assessing attitudes is to determine the evaluative connotation of concepts, objects, events, persons, etc., which are potential targets for attitudes, using the Semantic Differential Technique.

The Semantic Differential Technique is a byproduct of the psycholinguistic studies of Osgood, Suci, and Tannenbaum (1957). In an effort to determine common apsects of connotative meaning, Osgood and his associates constructed a set of 76 scales whose content was identified by bipolar adjective pairs. The bipolar pairs were determined in a two-stage process: (1) a pool of commonly used adjectives was identified by asking people to name an adjective which they would use to describe one of a large number of nouns from the Kent-Rosanoff word list; and (2) pairing each adjective appearing with sufficiently large frequency (named by at least 5% of the sample) with an antonym selected from Roget's Thesaurus, 1951 edition. The selected pool of 76 scales was then used to rate a selected list of 20 concepts. Correlations between pairs of scales were computed, summing across concepts and subjects; and the qualification structure of the pool of adjective pairs was determined by centroid factor analysis of the resulting matrix of intercorrleations. The resulting factor structure identified three aspects of connotative meaning characterizing the 76 adjective pairs, identified as Evaluation, Dynamism, Stability, and Warmth.

Osgood suggested the use of the Semantic Differential Technique as a basis for assessing attitudes and offered evidence that use of this technique produces results which are highly correlated with attitude assessments obtained by other techniques, e.g., Thurstone scales. The basis of the use of the Semantic Differential Technique for attitude measurement is to obtain ratings of objects toward

which attitudes are to be assessed using scales with dominant factor loadings on the evaluative factor. He suggested that it might sometimes be advisable to embed evaluative scales in a set of nonevaluative scales.

In this project, the objects toward which attitudes were to be assessed were descriptions of pupil behavior which were interpreted as related to creativity and descriptions of pupil behavior which could be characterized as convergent, non-critical, or conforming behavior. Ten descriptions were characterized as creativity and the ten were characterized as convergent, non-critical, or conforming. In a pilot sample of teacher trainees not involved in the project, ratings of these 20 "concepts" were obtained using five evaluative scales: beneficial-harmful, superior-inferior, successful-unsuccessful, meaningful-meaningless, valuable-worthless. Analysis of data from this pilot group revealed significant interaction between concept and scale and quite high internal consistency of ratings of both "positive" and "negative" concepts. For the final form of the attitude survey, two principal changes were made in the structure of the survey. First, four concepts were eliminated for one of three reasons: the concepts were substantially implicated in concept by scale interaction; the content of the concept appeared to be only moderately related, either positively or negatively, to conceptions of creativity consistent with the aims of the project; or the ratings of positive concepts were not substantially different from ratings of their negative counterparts. Second, in the final form, each positive concept was paired on the same page of the survey with a negative concept differing in content but approximately equivalent in its favorability as indicated by ratings in the pilot group. Third, in the revised form, scales were alternately directed toward positive and negative ratings; that is, for any concept, the scale beneficial-harmful or harmful-beneficial was followed by inferior-superior or superior-inferior. In scoring the survey, scale values ranged from 1 indicating negative valuation to 7 indicating positive valuation.

Reliability of the Observation Process

The following procedure was used to determine the reliability of the process of obtaining the number of hypotheses generated by each micro-group;

1. Observer 1 viewed the 30 video-tapes and recorded the number of hypotheses generated for each micro-teaching session.
2. Observer 2 viewed the 20 video-tapes for the No-Training and First Training groups while Observer 3 viewed the 10 video-tapes for the Second Training Group. The number of hypotheses generated for each micro-teaching session was recorded.
3. The two independent measurements for each video-tape were correlated and the Pearson product-moment correlation coefficient (r) was used as the measure of reliability.

Result: $r = .99$

The results in Table 1 show further the comparability of the two sets of measurements.

TABLE 1

HYPOTHESES RECORDED FOR 30 VIDEO-TAPES

Observer	Hypotheses Recorded			t
	Total	Mean	Std. Dev.	
1	505	16.8	9.81	.97*
2 and 3	528	17.6	9.88	

*Not statistically significant: $p > .20$

The number of hypotheses generated on each video-tape was divided by the length of the micro-teaching session so that two independent values for the index hyp/min were available for each video-tape. The correlation of these measures

was r = .99. Further results of the comparability of the two sets of measurements is given in Table 2.

TABLE 2

HYPOTHESES/MINUTE FOR 30 VIDEO-TAPES

Observer	Hypotheses/Minute		t
	Mean	Std. Dev.	
1	.755	.408	.14*
2 and 3	.778	.389	

*Not statistically significant: $p > .5$.

In the recording of intervals during which a behavior, as defined for the Expanded Interaction Analysis Category System, was observed the approximate length of the interval was three seconds. Theoretically, the number of intervals recorded should be given by the following formula:

No. of intervals = Length of session (in minutes) x 60 sec/min x 1 interval/3 sec

There were discrepancies with the ideal. However when the number of intervals observed for each video-tape was correlated with the expected number of intervals for each tape, the correlation was r = .99. Thus, any discrepancies are not a factor to be considered in the interpretation of results.

Because of the time involved it was not feasible to obtain independent measures of pupil divergent intervals for each tape. Further, the previous reliability evidence indicated that the observers were sufficiently well-trained to provide reliable observations.

Results and Discussion

Dependent Variable: Number of hypotheses generated

The length of session, number of hypotheses generated and the number of student divergency intervals for each of the three groups of preservice teachers are given in Table 3.

TABLE 3

LENGTH OF SESSION, NUMBER OF HYPOTHESES GENERATED AND NUMBER OF PUPIL DIVERGENCY INTERVALS

Group	N	Total Length of Sessions (minutes)	Total Number of Hypotheses Generated	Total Number of Pupil Divergent Intervals
No Training	10	186	91	306
First Training	10	259	224	1456
Second Training	10	266	213	708

The length of the individual micro-teaching sessions was not controlled. Since it could be expected that this variable would be related to the number of hypotheses generated it was necessary to control statistically for differences in length of session. However, it is reasonable to conclude that the concomitant variable, length of session, is influenced by treatments. For example, each training program provides the preservice teacher with a set of strategies for obtaining hypotheses from pupils. By employing these strategies the preservice teacher not only lengthens the session but may also generate more hypotheses.

Thus, if the usual analysis of covariance were used, by removing the effects of the length of session on the number of hypotheses generated one could also be removing treatment effects. Bottenberg and Ward (1) provide an appropriate linear model and a sequence of statistical tests to handle situations such as this, that is, the concomitant variable influenced by treatments.

The desired linear model is the following:

Model 0:

$$Y = b_1X^{(1)} + b_2X^{(2)} + b_3X^{(3)} + b_4P^{(4)} + b_5P^{(5)} + b_6P^{(6)} + e$$

where:

- Y is a vector with elements being the number of hypotheses generated in a given micro-teaching session (dimension: $n = 30$)
- $X^{(1)}$ is a vector in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the NT group; 0 otherwise
- $X^{(2)}$ is a vector in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the 1 Tr group; 0 otherwise
- $X^{(3)}$ is a vector in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the 2 Tr group; 0 otherwise
- $P^{(i)}$ ($i = 4,5,6$) are vectors in which the elements are the length of session uninfluenced by treatments when the corresponding element in the Y vector comes from a preservice teacher in the NT, 1 Tr or 2 Tr group respectively; 0 otherwise
- b_i ($i = 1, 2,\ldots,6$) are least squares weights
- e is a vector of residuals

The difficulty with using this model is that it requires values in the vectors $P^{(4)}$, $P^{(5)}$, and $P^{(6)}$ which are unobserved, namely, the length of the session uninfluenced by the treatment. However, under the assumption that the effect of a

given treatment on the length of the session is constant over time, a linear model equivalent to Model 0 can be derived. (A constant treatment effect is a common assumption.)

An equivalent linear model is the following:

Model 1:

$$Y = c_1X^{(1)} + c_2X^{(2)} + c_3X^{(3)} + b_4(X^{(4)} - m_1X^{(1)}) + b_5(X^{(5)} - m_2X^{(2)}) + b_6(X^{(6)} - m_3X^{(3)}) + e$$

where:

Y is a vector with elements being the number of hypotheses generated in a given micro-teaching session (dimension: n = 30)

$X^{(1)}$ is a vector in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the NT group; 0 otherwise

$X^{(2)}$ is a vector in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the 1 Tr group; 0 otherwise

$X^{(3)}$ is a vector in which the element is a 1 if the corresponding elements in the Y vector comes from a preservice teacher in the 2Tr group; 0 otherwise

m_i (i=1,2,3) is the mean length of session for the NT, 1 Tr and 2 Tr groups respectively

$X^{(i)}$ (i=4,5,6) are vectors in which the elements are the observed length of session if the corresponding element in the Y vector comes from a preservice teacher in the NT, 1 Tr, or 2 Tr group respectively; 0 otherwise

c_i (i=1,2,3) and b_j (j=4,5,6) are least-squares weights

e is a vector of residuals

The statistical analysis is that of the linear multiple regression model. The square of the multiple correlation coefficient, R^2, is an index which measures the reduction in the error sum of squares of the dependent variable Y brought about by the incorporation of one or more variables into the regression model. The general strategy, however, is to begin with a model that includes all variables of interest, then to remove certain variables from the model in accordance with the

particular hypothesis to be tested, and, finally, to determine if R^2 is lowered significantly (in a statistical sense). If removal of certain variables from the model does not significantly lower R^2, this is evidence that the presence of those variables in the model adds no information with respect to "explaining" differences in number of hypotheses generated among the various micro-groups. Similarly, if R^2 is lowered significantly by the removal of certain variables from the model, this is evidence that those variables should remain in the model since they do add "explanatory" information.

The initial statistical hypothesis tested was whether the change in the number of hypotheses generated per unit change of time is the same for the three treatment groups. Specifically, the null hypothesis was $b_4 = b_5 = b_6 = b_k$ and unelss this hypothesis is tenable, it is not possible to test for possible treatment effects.

If the hypothesis is tenable, placement of the restriction $b_4 = b_5 = b_6 = b_k$ on Model 1 leads to the following model:

Model 2:

$$Y = c_1X^{(1)} + c_2X^{(2)} + c_3X^{(3)} + b_k \underline{/\overline{Z}} - m_1X^{(1)} - m_2X^{(2)} - m_3X^{(3)}\underline{\overline{J}} + t$$

where:

Z is a vector in which the elements are the length of session in minutes for the corresponding element in the Y vector

t is a vector of residuals

Then $R^2_{\text{Model 1}} = .517$ $\quad R^2_{\text{Model 2}} = .475$

The appropriate test statistic is the usual F-statistic. The comparison of the two R^2's leads to F = 1.032 which for 2 and 24 degrees of freedom is not significant at the .05 level.

The principal hypothesis of interest is whether the three groups were equally effective over the range of observed times in the humber of hypotheses generated. This is equivalent to the restriction $c_1 = c_2 = c3 = c_o$ which leads to the following

model:

Model 3:

$$Y = c_o U + b_o \overline{Z} - m_1 X^{(1)} - m_2 X^{(2)} - m_3 X^{(3)} \overline{7} + w$$

where: U is the unit vector and w is the vector of residuals

Then $R^2_{\text{Model 3}} = .104$

When the R^2 for Model 3 is compared to the R^2 for Model 2 the resulting value of the F-statistic is F = 9.19 which for 2 and 26 degrees of freedom is significant at the .01 level.

To determine which groups differed in effectiveness three pair-wise comparisons were made. These are summarized in Table 4.

TABLE 4

SUMMARY OF PAIR-WISE COMPARISONS

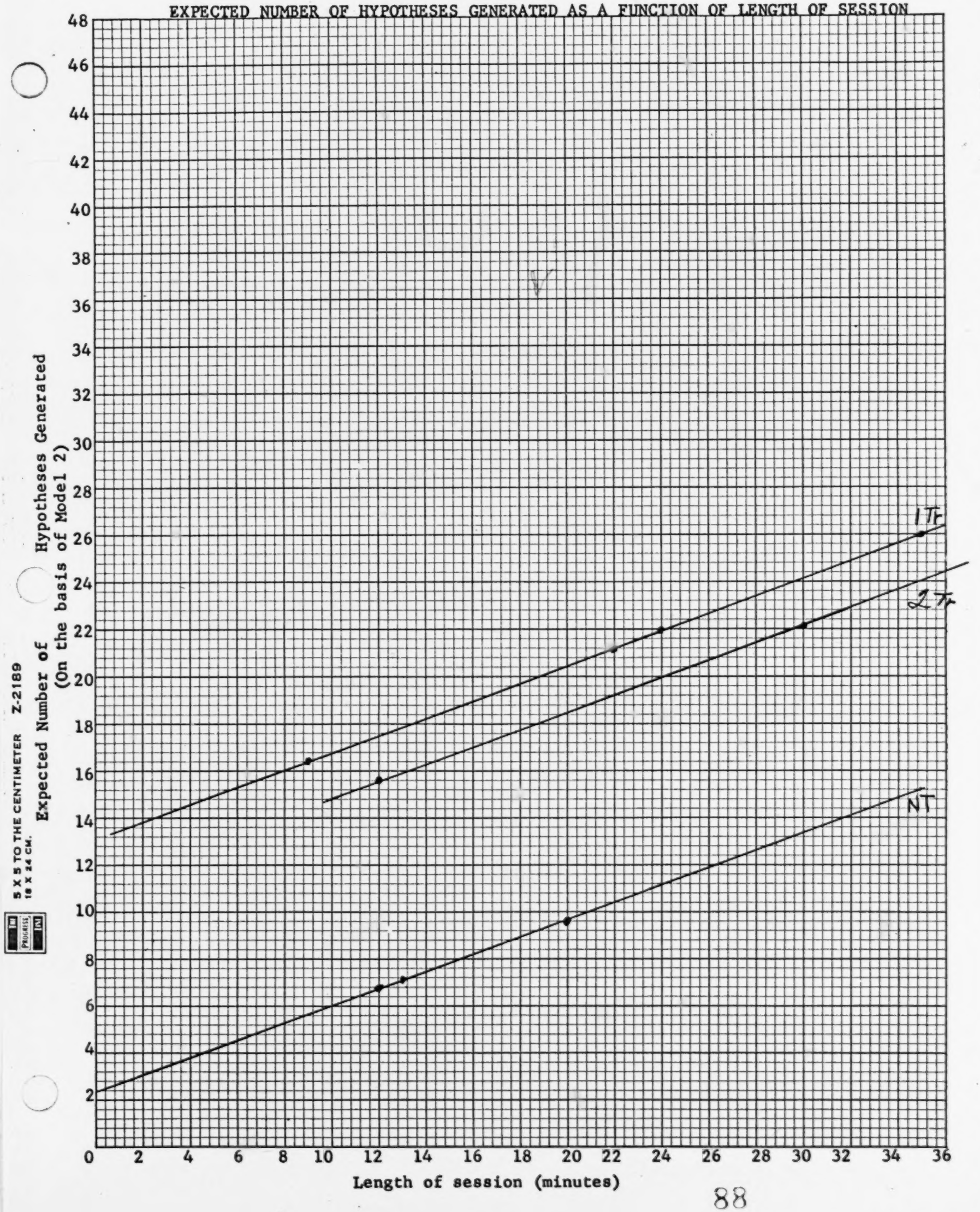
Comparison	Restriction on Model 2	Resulting R^2	Resulting F (Comparison With Model 2)
NT vs 1 Tr	$c_1 = c_2$	.174	14.90*
NT vs 2 Tr	$c_1 = c_3$	.222	12.50*
1 Tr vs 2 Tr	$c_2 = c_3$	.474	.05

*Statistically significant: $p < .01$

The expected number of hypotheses (on the basis of Model 2) for each of the three treatment groups is given as a function of length of session in Figure 1. For a given length of session the difference between 1 Tr and 2 Tr is not statistically significant; however, the difference between each trained group and the NT group is statistically significant. Each trained group was more effective in generating hypotheses than the NT group.

FIGURE 1

EXPECTED NUMBER OF HYPOTHESES GENERATED AS A FUNCTION OF LENGTH OF SESSION



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Dependent Variable: Number of pupil divergent intervals

Divergent responses are often indicative of behavior which is characterized as creative. Thus, it was of interest to investigate the effects of the training programs along this dimension. In the data analysis, length of session was, once again, treated as a concomitant variable influenced by treatments. Models analogous to those in the previous section were developed; in fact, the principal difference is that the elements of the Y vector are now "the number of pupil divergent intervals" for each micro-session.

An appropriate linear model which incorporates the observed times for the length of session is the following:

Model 4

$$Y = c_1X^{(1)} + c_2X^{(2)} + c_3X^{(3)} + b_4(X^{(4)} - m_1X^{(1)}) + b_5(X^{(5)} - m_2X^{(2)}) + b_6(X^{(6)} - m_3X^{(3)}) + s$$

where:

- Y is a vector with elements being the number of student divergent intervals in a given micro-teaching session (dimension: $n = 30$)
- s is the vector of residuals
- c_i, $X^{(i)}$, b_j, m_i are as defined in Model 2

The initial hypothesis tested was whether the change in the number of pupil divergent intervals per unit change of time is the same for the three treatment groups. This is equivalent to the following restriction on Model 4: $b_4 = b_5 = b_6 = b_k$. The restricted model has the form:

Model 5:

$$Y = c_1X^{(1)} + c_2X^{(2)} + c_3{}^{(3)} + b_k(Z - m_1X^{(1)} - m_2X^{(2)} - m_3X^{(3)}) + t$$

Then,

$R^2_{\text{Model 4}} = .556$ and $R^2_{\text{Model 5}} = .471$

The comparison of these two R^2's yields an F-value of 2.03 which for 2 and 24

degrees of freedom is not significant at the .05 level. Thus, it is possible to continue with the analysis.

The principal hypothesis of interest in this section is whether there were differences among the three groups in terms of the number of pupil divergent intervals observed. This is equivalent to the restriction $c_1 = c_2 = c_3 = c_o$ on Model 5.

The restricted model has the form:

Model 6:

$$Y = c_o U + b_o(Z - m_1 X^{(1)} - m_2 X^{(2)} - m_3 X^{(3)}) + w$$

where:

U is the unit vector

w is the vector of residuals

Then,

$R^2_{\text{Model 5}} = .471$ and $R^2_{\text{Model 6}} = .177$

The comparison of these two R^2's yields an F = 7.23 which is significant at the .01 level.

To determine which differences in the number of pupil divergent intervals between the groups were significant, three pair-wise comparisons were made. These are summarized in Table 5.

TABLE 5

SUMMARY OF PAIR-WISE COMPARISONS

Comparison	Restriction on Model 5	Resulting R^2	Resulting F (Comparison with Model 5)
NT vs 1 Tr	$c_1 = c_2$	.185	14.04*
NT vs 2 Tr	$c_1 = c_3$	.437	1.66
1 Tr vs 2 Tr	$c_2 = c_3$	.351	5.95**

*Statistically significant: $p < .01$.

**Statistically significant: $p < .05$.

In Figure 2 the expected number of pupil divergent intervals (on the basis of Model 5) for each of the three treatment groups is given as a function of length of session. For a given length of session the number of pupil divergent intervals for the 1 Tr group was significantly greater than for either the NT group or the 2 Tr group. The observed difference between the 2 Tr and the NT groups was not statistically significant.

Dependent Variable: Number of pupil talk intervals

The analysis for this section is analogous to that of the previous ones. Length of session was once again treated as a concomitant variable influenced by treatments and appropriate linear models were developed. It was found that there was no significant difference among the three treatment groups in terms of the number of pupil talk intervals.

Dependent Variable: Number of hypotheses per minute

In a somewhat different analysis the length of session can be taken into account in the formation of a "productivity" index, namely, number of hypotheses generated per minute. With this index as the dependent variable a factorial analysis of variance was carried out. The independent variables were Training Program (NT, 1 Tr and 2 Tr) and Grade Level (K, 3, 7, 10, 12). The results are presented in Tables 6 and 7.

These results indicate that the three groups of preservice teachers were not equally effective in terms of hypotheses generated/minute. Employment of Tukey's procedure ($\alpha = .05$) as a follow-up (2) shows no significant difference between 1 Tr and 2 Tr groups. However, both the 1 Tr and 2 Tr groups were significantly more "productive" than the NT group. The interaction of Training Program and Grade Level was not statistically significant.

FIGURE 2

EXPECTED NUMBER OF PUPIL DIVERGENT INTERVALS AS A FUNCTION OF LENGTH OF SESSION

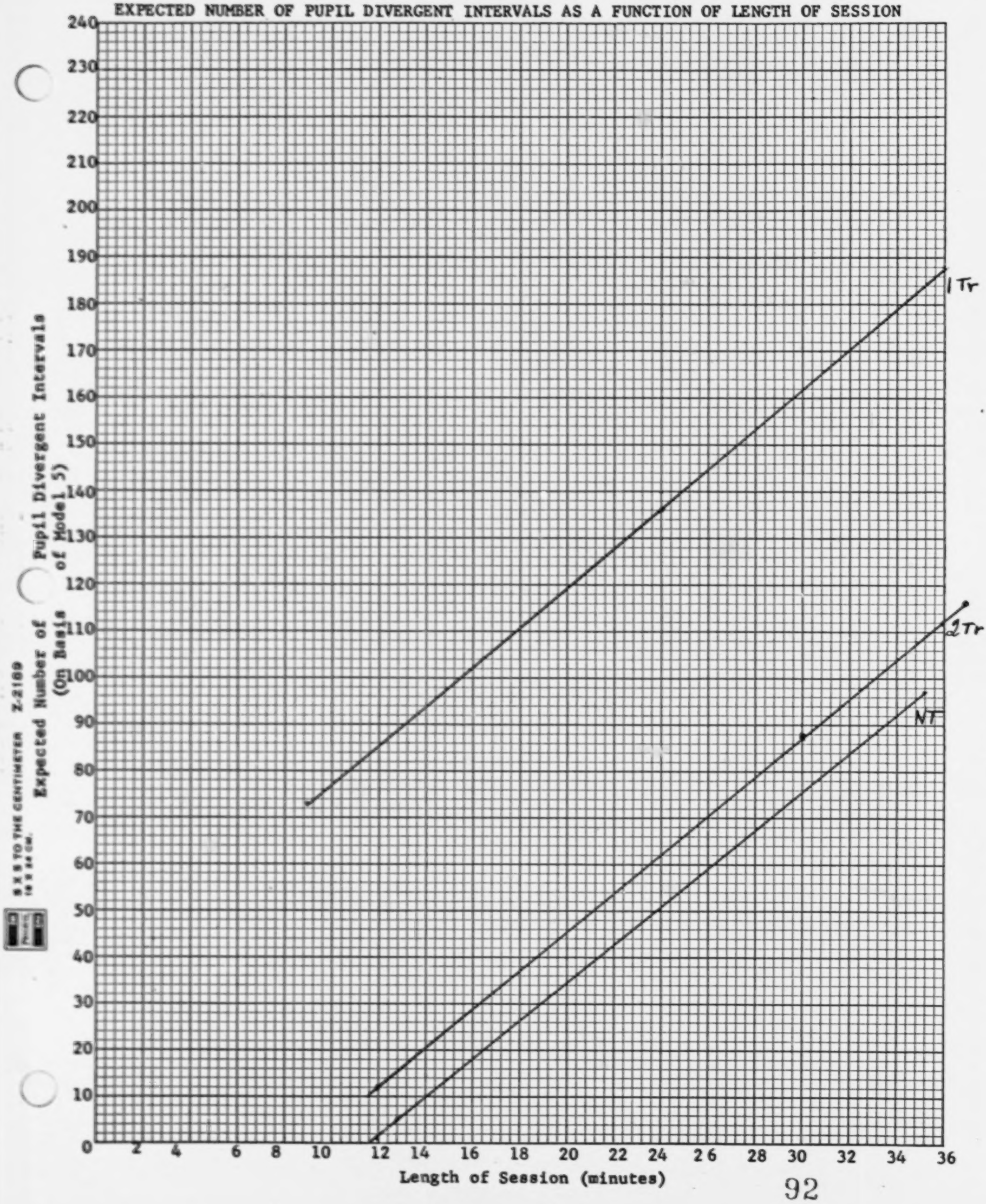

TABLE 6

MEAN NUMBER OF HYPOTHESES PER MINUTE AS A FUNCTION OF TRAINING PROGRAM AND GRADE LEVEL

Grade Level	Training Program			Grade Level Mean
	NT	1 Tr	2 Tr	
K	.89	1.62	1.07	1.19
3	.57	1.30	.62	.83
7	.40	.66	.93	.67
10	.31	.57	.51	.47
12	.50	.64	1.05	.73
Training Program Mean	.54	.96	.84	

TABLE 7

HYPOTHESES/MINUTE: ANOVA RESULTS

Source of Variation	DF	F	Prob.
Training Program	2	8.19	$p < .01$
Grade Level	4	7.46	$p < .01$
Interaction (Tr Prog x Gr Level)	8	2.13	$p < .10$
Residual	15		

The interpretation of differences in number of hypotheses per minute among grade levels is not a direct concern of this project. However, there is a widespread belief that creative behavior of pupils tends to diminish as they proceed through the educational system. To see if the results of this project are consistent with that belief Tukey's follow-up procedure was applied to the observed differences

among grade levels. To be statistically significant (.05 level) observed differences must be .43 or larger. When the differences in grade level means (Table 6) are compared with this value, it can be seen that for Grade K the hypotheses per minute were significantly greater than for Grades 7, 10 and 12.

Dependent Variable: Teacher attitude

To study the effect of the training programs on teacher attitude the Pupil Behavior Opinion Survey was administered to the three groups of preservice teachers both as a pre-test and as a post-test. The pre-test scores were analyzed using a fixed model factorial analysis of variance. The independent variables were Training Program (NT, 1 Tr and 2 Tr) and Grade Level (K, 3, 7, 10, 12). There were no significant differences among grade levels and among treatments and there was no significant interaction. These results are summarized in Tables 8 and 9.

Since there was no evidence to suggest differences among the various groups, the post-test scores were analyzed independently of the pre-test scores. (While there is interest in "change in teacher attitude" the psychometric properties of the change score make it an undesirable measure. If the groups are reasonably equivalent to begin with, differential changes in attitude among the groups will show up as differences on the post-test.) The post-test results are presented in Tables 10 and 11. The observed differences among treatment groups as well as those among grade levels were not statistically significant. However, there was a significant interaction.

TABLE 8

PRE-TEST TEACHER ATTITUDE (MEANS)

Grade Level	Training Program			Grade Level Mean
	NT	1 Tr	2 Tr	
K	366.5	373.5	374.5	371.5
3	337.5	340.5	351.0	343.0
7	394.5	341.0	370.0	368.5
10	376.5	376.5	356.0	369.7
12	369.0	381.0	351.5	367.2
Training Program Mean	368.8	362.5	360.6	

TABLE 9

PRE-TEST TEACHER ATTITUDE: ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	2	.28	$p > .25$
Grade Level	4	1.25	$p > .25$
Interaction (Tr Prog x Gr Level)	8	.79	$p > .25$
Residual	15		

Follow-up procedures indicate that there are no significant differences among the NT, 1 Tr and 2 Tr groups at any of the grades K, 3, 7, or 10. However, the attitude of the 1 Tr group at grade 12 was significantly more positive than that of either the NT or 2 Tr group at that grade level (Tukey's w and $\alpha = .05$).

TABLE 10

POST-TEST-TEACHER ATTITUDE (MEANS)

Grade Level	Training Program			Grade Level Mean
	NT	1 Tr	2 Tr	
K	365.5	396.5	353.5	371.8
3	343.5	340.5	394.5	359.5
7	383.0	357.5	374.0	371.5
10	368.5	373.5	351.5	364.5
12	369.0	471.5	361.0	400.5
Training Program Mean	365.9	387.9	366.9	

TABLE 11

POST-TEST-TEACHER ATTITUDE: ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	2	2.83	$p < .10$
Grade Level	4	2.78	$p < .10$
Interaction (Tr Prog x Gr. Level)	8	4.34	$p < .01$*
Residual	15		

*The interaction is significant.

Dependent Variable: Pupil Divergency as Percentage of Pupil Talk

Presumably, if pupils' responses are divergent in nature they could eventually be led more easily into generating hypotheses. Thus, the percentage of pupil talk intervals which were divergent was used as a dependent variable. Again the data were analyzed by the fixed model factorial analysis of variance.

The results are given in Tables 12 and 13.

TABLE 12

PUPIL DIVERGENT INTERVALS AS A PERCENTAGE OF PUPIL TALK (MEANS)

Grade Level	Training Program			Grade Level Mean
	NT	1 Tr	2 Tr	
K	27	72.5	29	42.8
3	13	70.5	15.5	33.0
7	4	57.5	31.5	31.0
10	19	33	17.5	23.2
12	16.5	29	32.5	26.0
Training Program Mean	15.9	52.5	25.2	

TABLE 13

PUPIL DIVERGENT INTERVALS AS A PERCENTAGE OF PUPIL TALK: ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	2	16.87	$p < .01$
Grade Level	4	1.61	$p > .10$
Interaction	8	1.79	$p > .10$
Residual	15		

The difference between training programs is significant at the .01 level. The use of Tukey's procedure as a follow-up indicates that for the 1 Tr group the percentage of pupil talk which was divergent was significantly greater ($\alpha = .05$) than that for either the 2 Tr or NT groups. The difference between the

NT and 2 Tr groups was not significant ($\alpha = .05$).

Summary

1. Preservice teachers trained under the first program and those trained under the second program were able to elicit significantly more hypotheses from the micro-groups than were those preservice teachers who were not trained. No difference between the two training programs was indicated.

2. The preservice teachers trained under the first program were significantly more effective in obtaining pupil divergent responses than were the preservice teachers who were either not trained or who were trained under the second program. There was no significant difference between the latter two groups.

3. There was no significant difference among the three groups of preservice teachers in terms of the amount of pupil talk.

4. Preservice teachers trained under either the first or second program were significantly more "productive" than those preservice teachers not trained. (The measure of "productivity" was the number of hypotheses generated per minute.) No difference between the two training programs was indicated.

5. At grade level 12 a more positive attitude toward pupil behavior associated with creativity was observed for the two preservice teachers trained under the first program than for the other four preservice teachers for that grade level. No other differences in attitude were indicated.

6. In those micro-sessions conducted by preservice teachers trained under the first program, the percentage of pupil talk which was divergent was significantly greater than in those sessions conducted by the remaining two groups of preservice teachers. There was no significant difference between the latter two groups.

Search for Operational Guidelines

The evidence indicates that if preservice teachers are trained under either of the two programs they are more likely to elicit from pupils certain behaviors which may be classified in the creative domain. What did not materialize was the expected superiority of the second training program. Since this project is primarily developmental in nature it appeared reasonable to examine the data further for possible explanations. An analysis was made of the cumulated number of hypotheses plotted as a function of time, for each preservice teacher (see data included in Appendix H). It was clear that the initial segment of the sessions for preservice teachers trained under the second program was a period of rapid hypothesizing. What was also evident was the fact that the remainder of the sessions was almost totally nonproductive in many instances. What appeared to be needed was some type of a "stop" criterion which would signal the beginning of the nonproductive phase of the session. One possible stop criterion is a three-minute interval following any period of hypothesizing in which no hypothesis is generated. This stop criterion was imposed ex post facto on the two training programs and the resulting data were reanalyzed. These data are presented in Table 14. The two dependent variables considered were: (1) the number of hypotheses generated, and (2) the number of hypotheses generated per minute.

From these data it is readily apparent that for the preservice teacher in the second training program there was a large portion of unproductive time at the end of the session.

Dependent Variable: Number of Hypotheses Generated (With Stop Criterion Imposed)

This phase of the analysis will be concerned only with a comparison of the two training programs. The length of session will be treated as a concomitant variable influenced by treatments and the linear multiple regression model will be the statistical technique employed.

TABLE 14

DATA RESULTING WHEN STOP CRITERION IS IMPOSED

	Data for Session Up to the Point Stop Criterion is Imposed			Data for Session After the Point Stop Criterion is Imposed		
	Length of Session (Min.)	No. of Hyp.	Hyp/Min (Mean)	Length of Session (Min.)	No. of Hyp.	Hyp/Min (Mean)
1 Tr	196	190	.94	63	32	.46
2 Tr	142	170	1.15	124	36	.24

The specific linear model tested is the following:

Model 7:

$$Y = c_1X^{(1)} + c_2X^{(2)} + b_3(X^{(3)} - m_1X^{(1)}) + b_4(X^{(4)} - m_2X^{(2)}) + x$$

where:

Y is a vector with elements being the number of hypotheses generated in a given micro-teaching session prior to the time stop criterion ends the session (dimension: n = 20)

$X^{(i)}$ i = 1, 2 are vectors in which the element is a 1 if the corresponding element in the Y vector comes from a preservice teacher in the 1 Tr and 2 Tr groups respectively; 0 otherwise

$X^{(j)}$ j = 3, 4 are vectors in which the elements are the observed length of session (stop criterion imposed) if the corresponding element in the Y vector comes from a preservice teacher in 1 Tr and 2 Tr groups respectively; 0 otherwise

m_i (i=1,2) is the mean length of session (stop criterion imposed) for the 1 Tr and 2 Tr groups respectively

c_i (i=1,2) and b_j (j=3,4) are least squares weights

s is a vector of residuals

With the restriction $b_3 = b_4 = b_k$ applied to Model 7 then:

Model 8:

$$Y = c_1X^{(1)} + c_2X^{(2)} + b_k(X^{(3)} + X^{(4)} - m_1X^{(1)} - m_2X^{(2)}) + t$$

and

$R^2_{\text{Model 7}} = .514$ and $R^2_{\text{Model 8}} = .510$

The resulting F-value is .13 which is not statistically significant (.05 level). Thus, the sequence of hypothesis testing may appropriately continue.

The main hypothesis of interest is whether there is a difference between the 1 Tr and 2 Tr groups in terms of number of hypotheses generated when the stop criterion is imposed. This is equivalent to the restriction $c_1 = c_2 = c_o$ and leads to:

Model 9:

$$Y = c_o U + b_k(X^{(3)} + X^{(4)} - m_1 X^{(1)} - m_2 X^{(2)}) + v$$

where:

U is the unit vector

Then,

$R^2_{\text{Model 8}} = .510$ and $R^2_{\text{Model 9}} = .499$

The resulting F-value is .38, which is not statistically significant (.05 level). That is, there was no evidence to indicate any difference between the two training programs in terms of hypotheses generated when the stop criterion was imposed.

Dependent Variable: Hypotheses per Minute (With Stop Criterion Imposed)

The results for this part of the analysis are given in Tables 15 and 16. The method of data analysis was the fixed model factorial analysis of variance.

The evidence is not sufficient to conclude that there is a true difference in the hypotheses/minute for the two training programs when the stop criterion is imposed.

Dependent Variable: Number of Hypotheses (Based on 11 minute Maximum Session)

The micro-sessions for both groups were terminated ex post facto after 11 minutes and the number of hypotheses generated was retabulated. (This criterion was applied since the median length of the period of rapid hypothesizing was 11 minutes for the 2 Tr group.) The results of this analysis are presented in

TABLE 15

HYPOTHESES PER MINUTE (STOP CRITERION IMPOSED)

Grade Level	Training Program		Grade Level Mean
	1 Tr	2 Tr	
K	1.68	1.33	1.51
3	1.32	1.05	1.19
7	.72	1.67	1.20
10	.59	.62	.61
12	.40	1.06	.73
Training Program Mean	.94	1.15	

TABLE 16

HYPOTHESES PER MINUTE (STOP CRITERION IMPOSED)--ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	1	1.33	$p > .25$
Grade Level	4	3.55	$p < .05$
Interaction	4	2.14	$p > .10$
Residual	10		

Tables 17 and 18. It can be seen that the number of hypotheses generated was significantly greater in the micro-sessions conducted by preservice teachers trained under the second program.

Dependent Variable: Number of Pupil Divergencies (Based on 11 minute Maximum Session)

The results are given in Tables 19 and 20 and they indicate no real difference between the two training programs in terms of the number of student divergencies.

TABLE 17

NUMBER OF HYPOTHESES (BASED ON 11 MINUTES MAXIMUM SESSION)--MEANS

Grade Level	Training Program		Grade Level Mean
	1 Tr	2 Tr	
K	18.0	18.5	18.25
3	15.0	14.5	14.75
7	6.5	20.5	13.50
10	4.5	8.0	6.25
12	6.0	14.0	10.00
Training Program Mean	10.0	15.1	

TABLE 18

NUMBER OF HYPOTHESES (BASED ON 11 MINUTE MAXIMUM SESSION)--ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	1	5.95	$p < .05$
Grade Level	4	3.87	$p < .05$
Interaction	4	1.63	$p > .10$
Residual	10		

TABLE 19

NUMBER OF PUPIL DIVERGENCIES (BASED ON 11 MINUTE MAXIMUM SESSION)--MEANS

Grade Level	Training Program		Grade Level Mean
	1 Tr	2 Tr	
K	58.5	25.0	41.75
3	80.0	35.5	57.75
7	88.0	58.5	73.25
10	24.0	25.0	24.50
12	32.5	35.0	33.75
Training Program Mean	56.6	35.8	

TABLE 20

NUMBER OF PUPIL DIVERGENCIES (BASED ON 11 MINUTE MAXIMUM SESSION)--ANOVA SUMMARY

Source of Variation	DF	F	Prob.
Training Program	1	3.77	$p < .10$
Grade Level	4	2.63	$p < .10$
Interaction	4	.79	$p > .25$
Residual	10		

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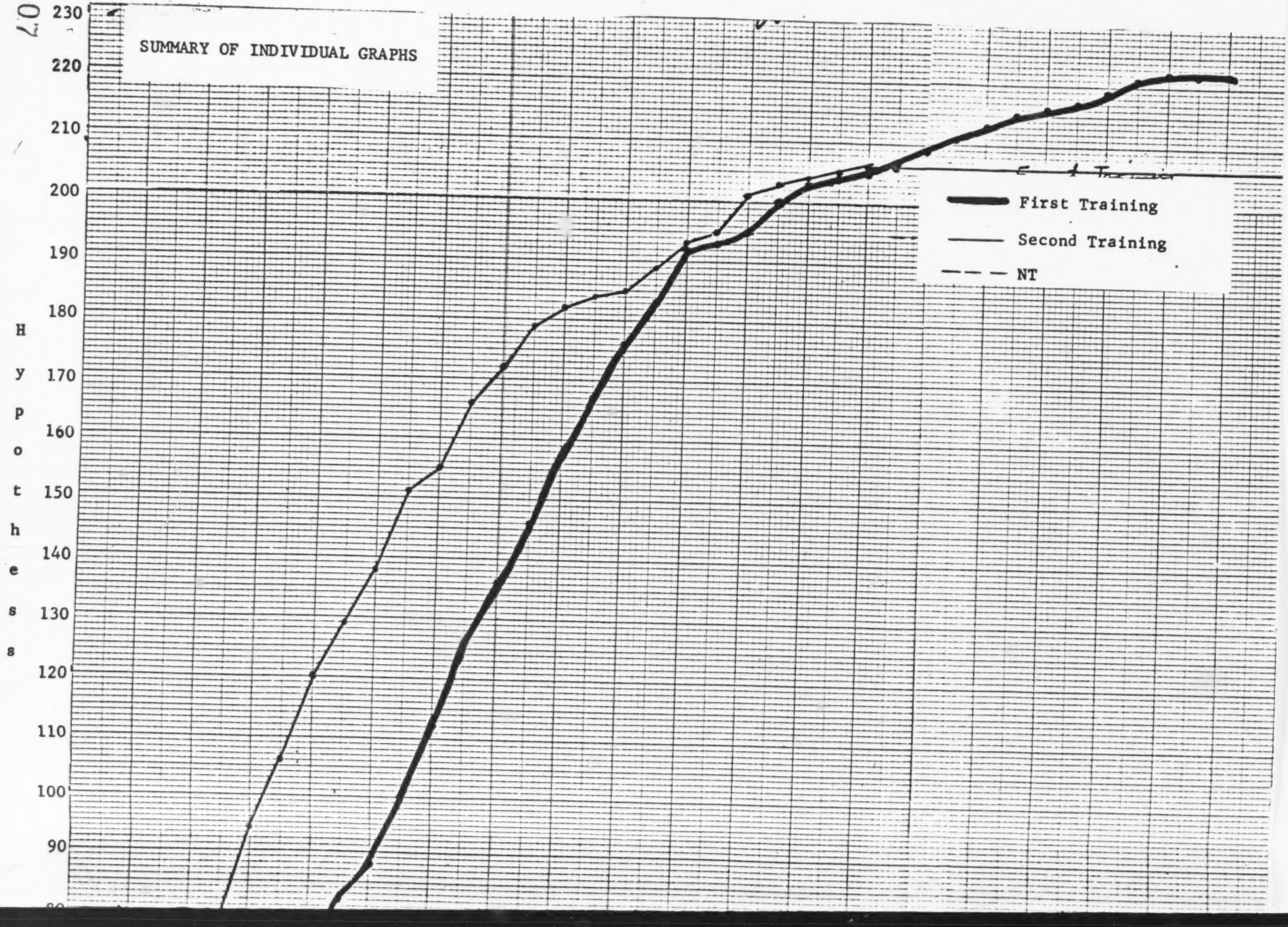
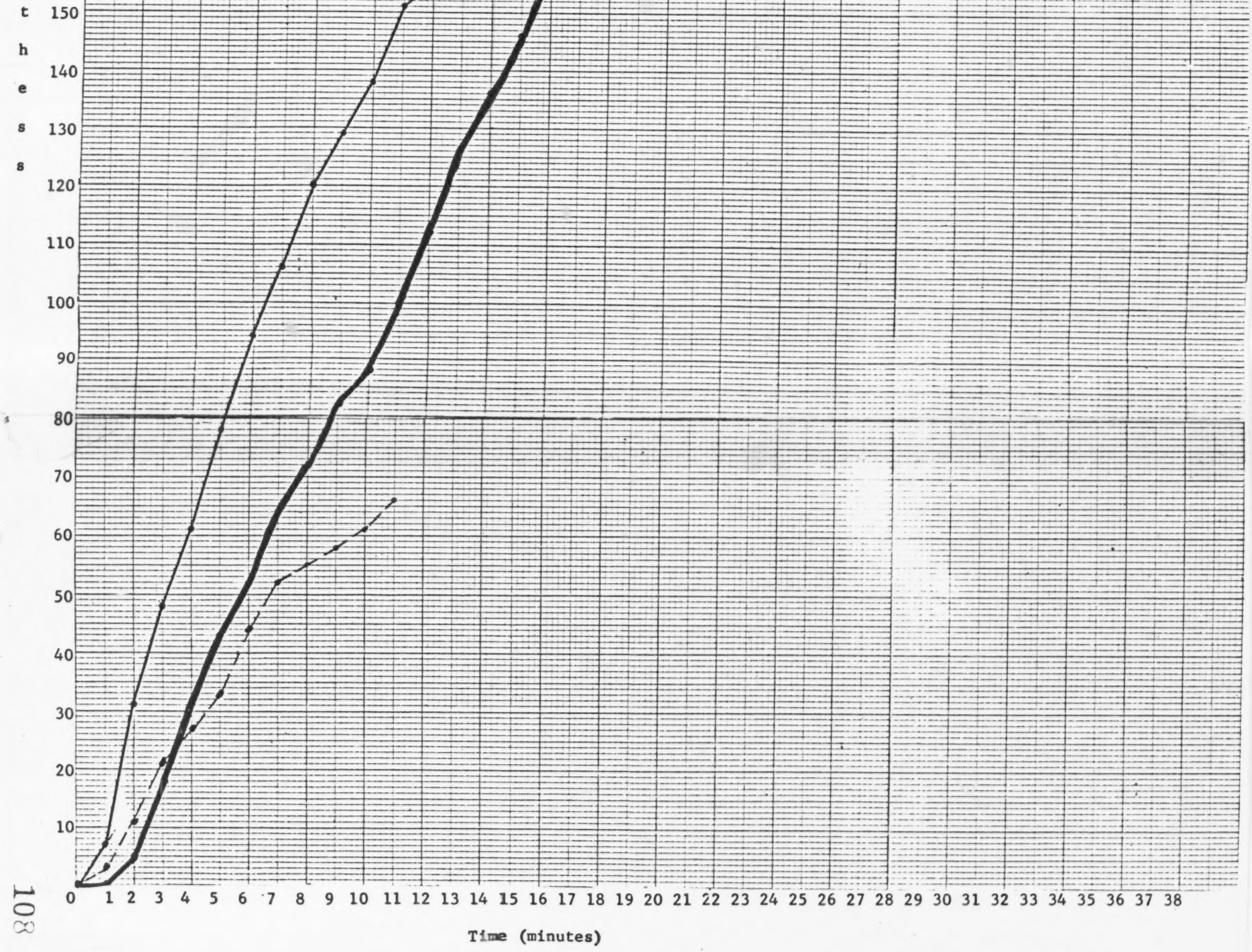
SUMMARY OF INDIVIDUAL GRAPHS

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Time (minutes)

APPENDIX H

HYPOTHESES GENERATED (NO-TRAINING, FIRST AND SECOND TRAINING GROUPS)

(1) Hypotheses: Cumulative Totals by Time
No-Training Group

(2) Recorded Hypotheses by Time
No-Training Group

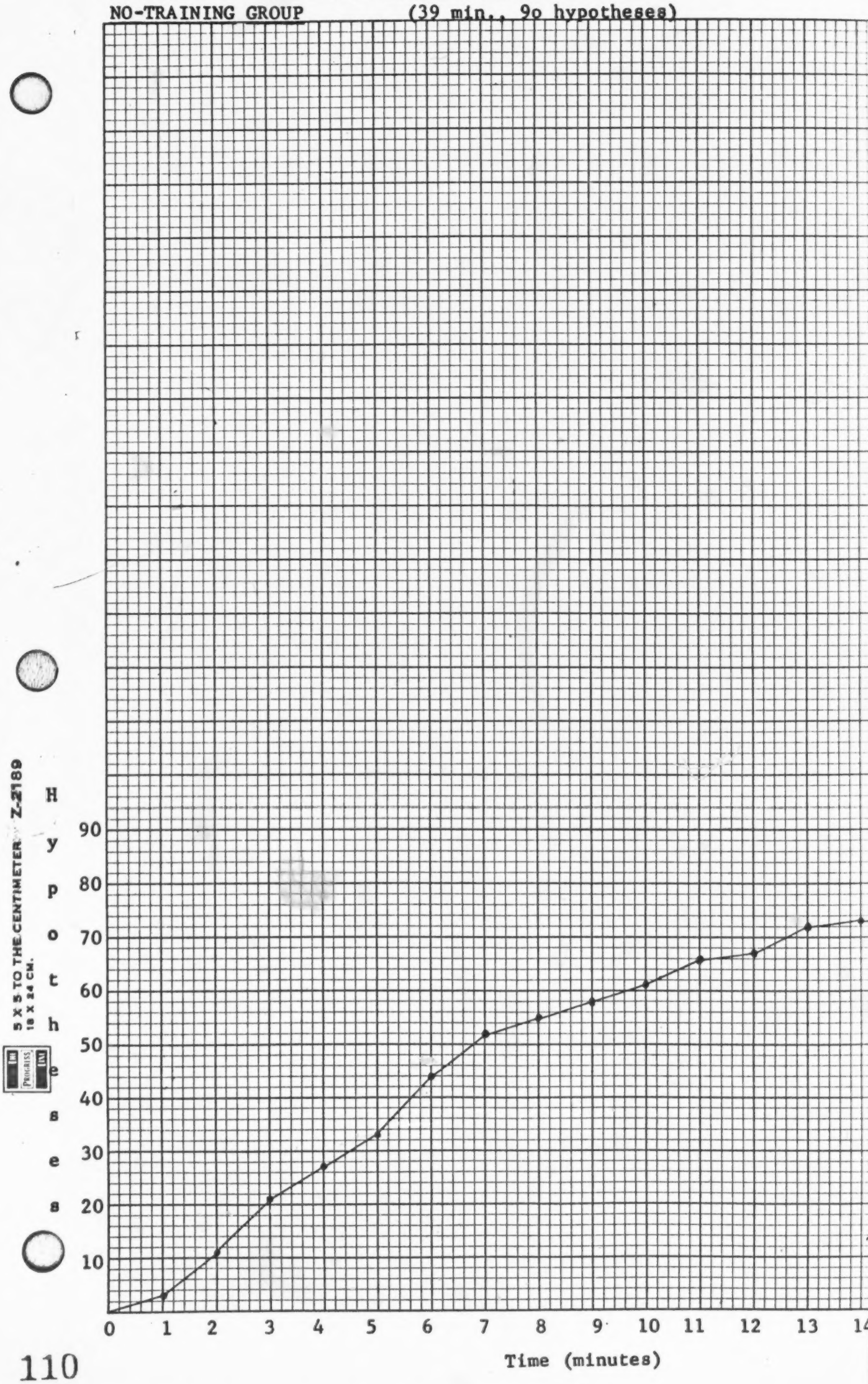
(3) Hypotheses: Cumulative Totals by Time
First Training Group

(4) Recorded Hypotheses by Time
First Training Group

(5) Hypotheses: Cumulative Totals by Time
Second Training Group

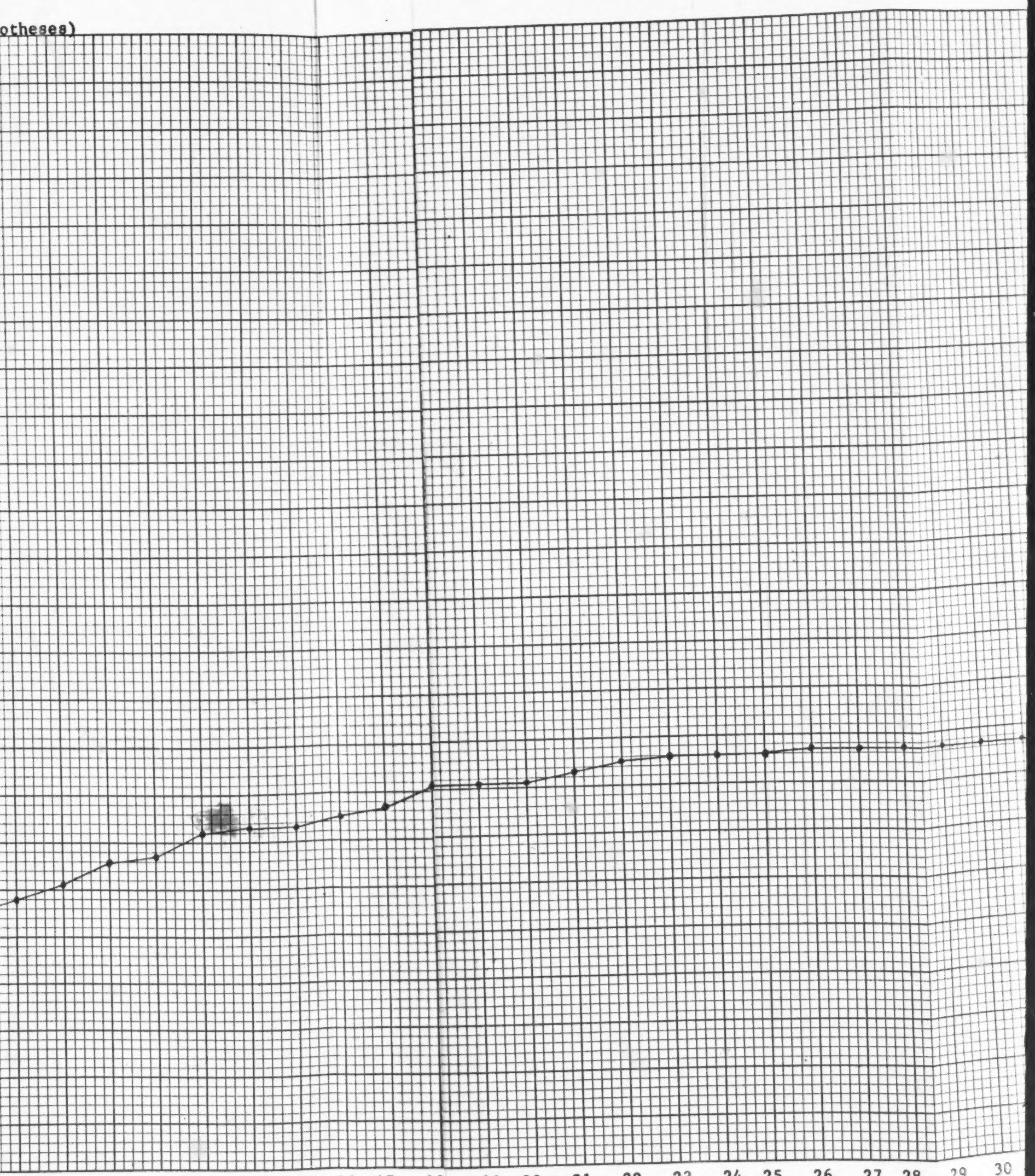
(6) Recorded Hypotheses by Time
Second Training Group

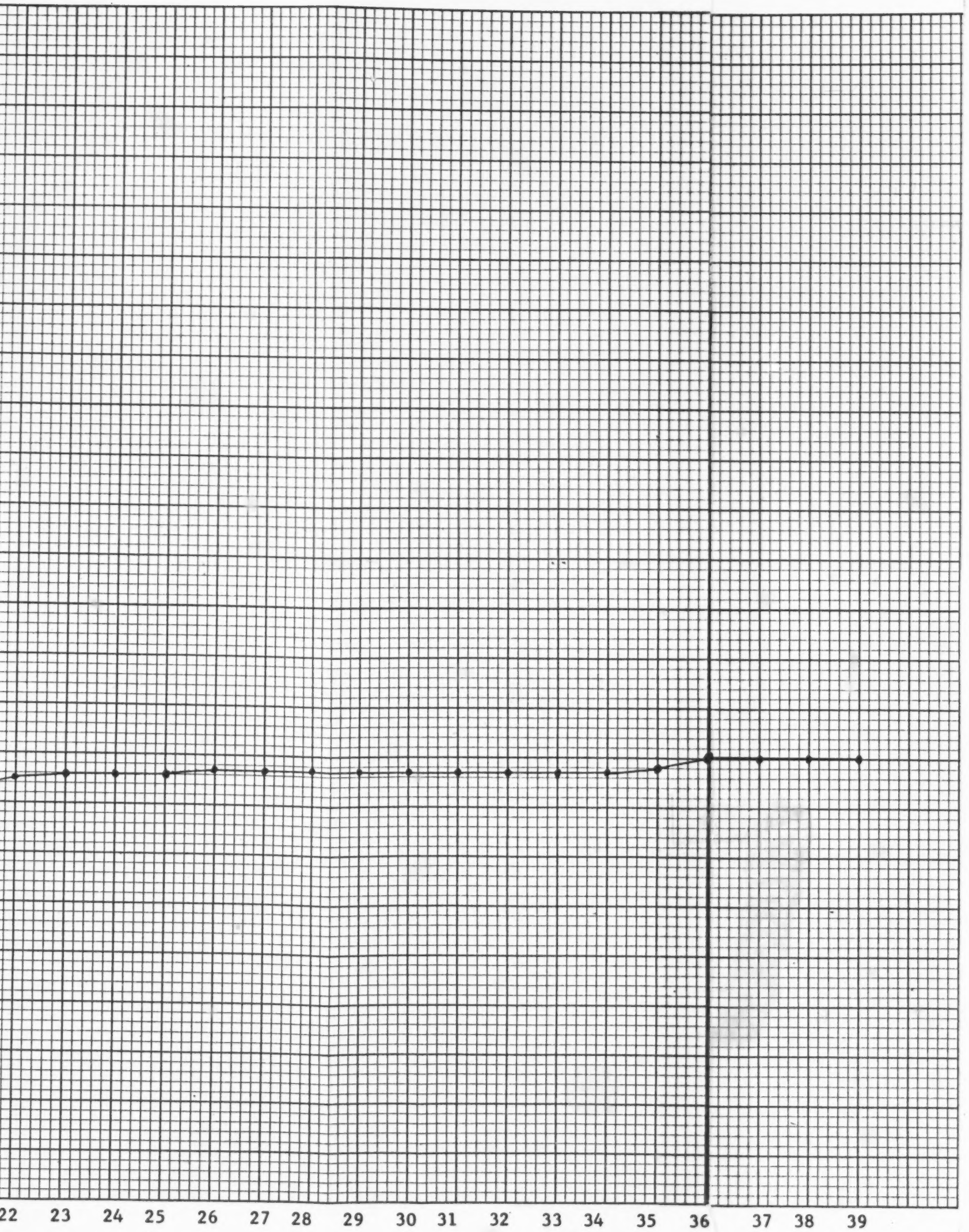
HYPOTHESES: CUMULATIVE TOTALS BY TIME
NO-TRAINING GROUP (39 min., 9o hypotheses)



5 X 5 TO THE CENTIMETER Z-2189
13 X 24 CM.

otheses)


9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
(minutes)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113

RECORDED HYPOTHESES BY NO-TRAINING GROUP

NAME	Minute Intervals 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
York	1	1	1	1	2	2	2	—	—	—	1	1	1					
Anderson	1	1	4	—	1	-	—	—	—									
Pitts	-	-	2	3	1	2	2	1	1	-	1	-	1	-	-	1	-	2
Keller	1	2	-	-	-	1	1	—	1	1	-	-	-	—	-	-	1	-
Johnson	-	3	-	1	-	1	-	1	-	-	1	-						
Paulson	-	-	-	1	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Wegner	-	-	-	-	-	2	1	-	-	-	-	-	1	-	-	1	-	
Ahrens	-	2	-	-	-	-	1	1	-	-	1	-	1	-	-			
Denker	-	-	3	-	1	2	-	-	-	-	1	1	-	1	-	-	1	2
Hout	-	-	-	-	1	-	1	-	1	1								
TOTAL	3	8	10	6	6	11	8	3	3	3	5	2	4	1	-	2	2	4
ACCUMULATED TOT.	3	11	21	27	33	44	52	55	58	61	66	68	72	73	73	75	77	81

RECORDED HYPOTHESES BY TIME 114

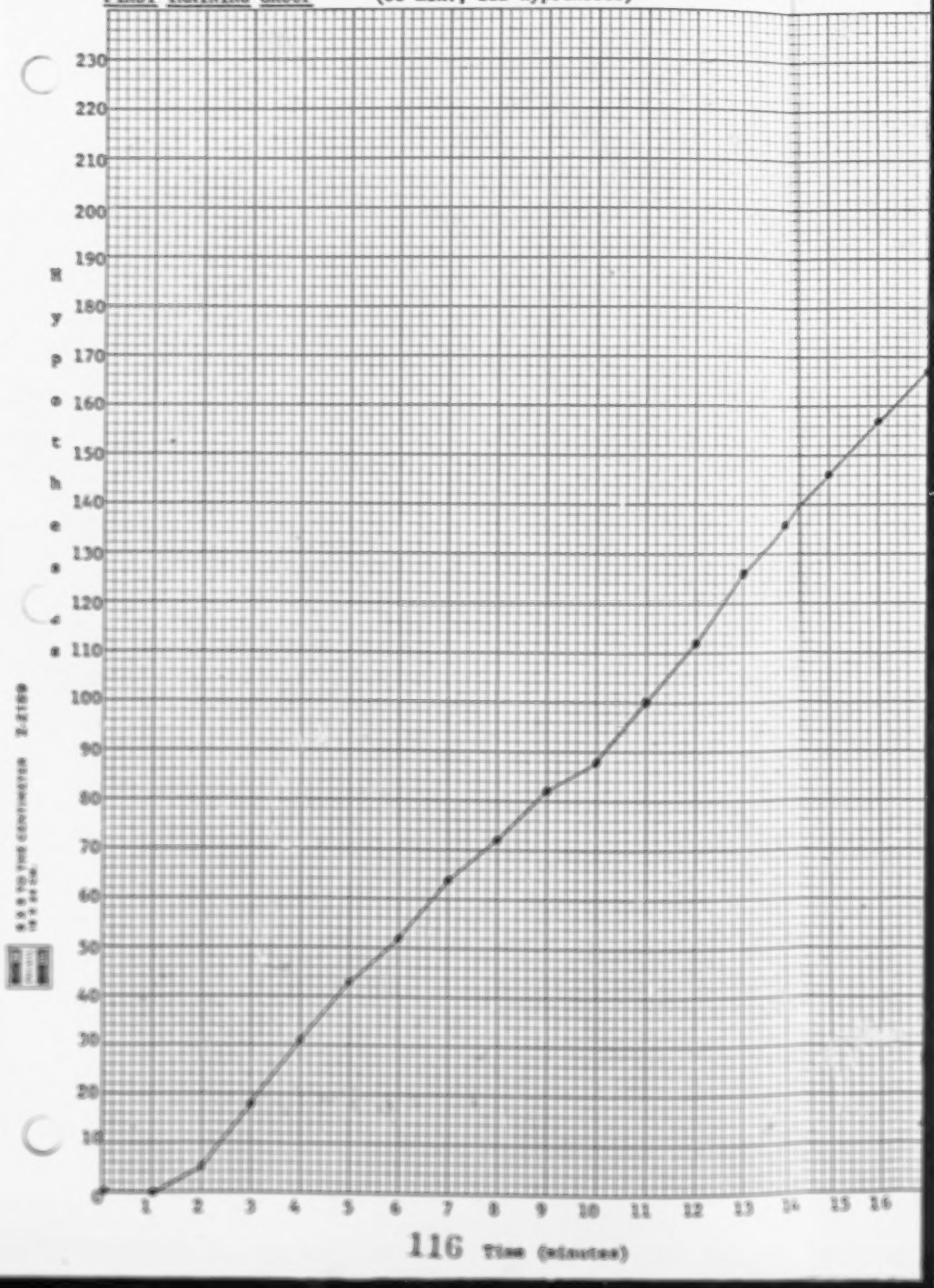
NO-TRAINING GROUP

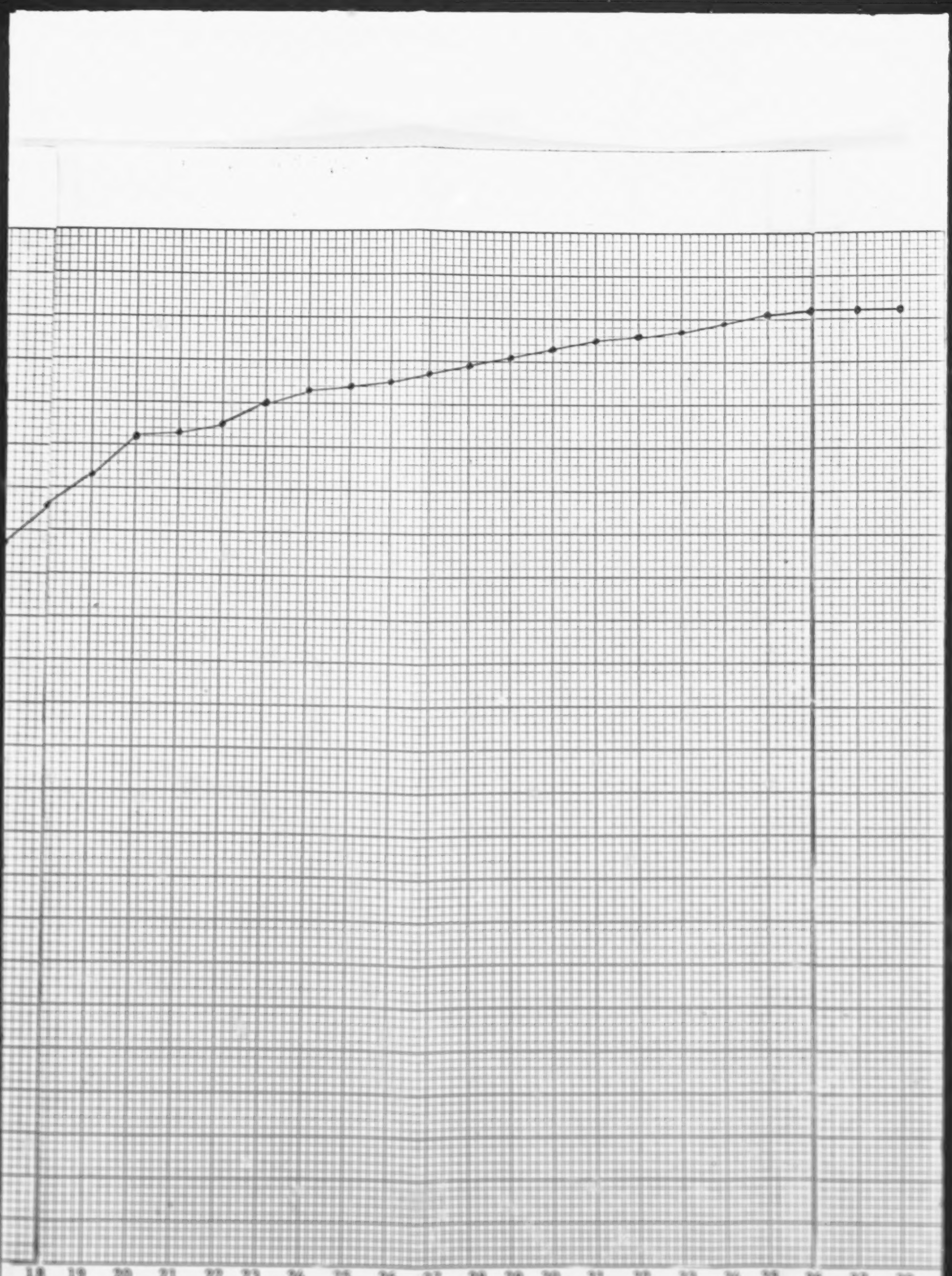
Minute Intervals

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
/	/	/																						
1	–	1	–	–	1	–	2	–	–															
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–							
1	–																							
–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	1
–	–	1	–	–	1	–																		
1	–	1	–	–												–								
1	1	–	1	–	–	1	2	–	–	1	2	1												
5	2	4	1	–	2	2	4	–	–	2	2	1	–	–	1	–	–	–	–	–	–	–	–	1
66	68	72	73	73	75	77	81	81	81	83	85	86	86	86	87	87	87	87	87	87	87	87	87	88

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	TOTAL HYPOTHESES
																			13
																			7
																			17
–	–	–	–	–															8
																			7
–	–	1	–	–	–	–	–	–	–	+	1	2	–	–	–				8
																			5
																			5
																			16
																			4
	–	1	–	–	–	–	–	–	–	–	1	2	–	–	–				90
86	87	87	87	87	87	87	87	87	87	88	90	90	90	90					90

HYPOTHESES: CUMULATIVE TOTALS BY TIME
FIRST TRAINING GROUP (38 min., 222 hypotheses)

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RECORDED HYPOTHESES BY TIME
FIRST TRAINING GROUP
Minute Intervals

NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Faikus	-	2	2	3	2	3	1	1	-									
Hagensick	-	3	3	5	4	-	2	1	1	-	3	1	2	1	1	2		
Steiner	-	-	2	-	2	2	1	5	1	3	2	3	1	2	1	2	2	1
Corry	-	-	3	1	3	-	2	-	2	-	1	1	1	-	2	1	1	1
Hoffman	-	-	1	1	-	1	2	-	-	-	1	-	2	1	1	1	-	2
Dietel	-	-	1	-	-	1	2	1	-	1	1	2	3	2	1	1	1	3
Dane	-	-	-	1	1	1	1	-	1	1	1	2	1	1	-	2	2	-
Nelson	-	-	-	-	-	-	-	-	1	-	1	1	1	1	2	-	1	1
Whisker	-	-	1	-	-	-	-	-	2	1	2	1	2	-	1	1	1	1
Veach	-	-	-	2	-	1	1	-	2	-	-	1	1	2	1	1	1	1
SUBTL.	0	5	13	13	12	9	12	8	10	6	12	12	14	10	10	11	9	10
CUMULATED TOT.	0	5	18	31	43	52	64	72	82	88	100	112	126	136	146	157	166	176

119

RECORDED HYPOTHESES BY TIME -107-

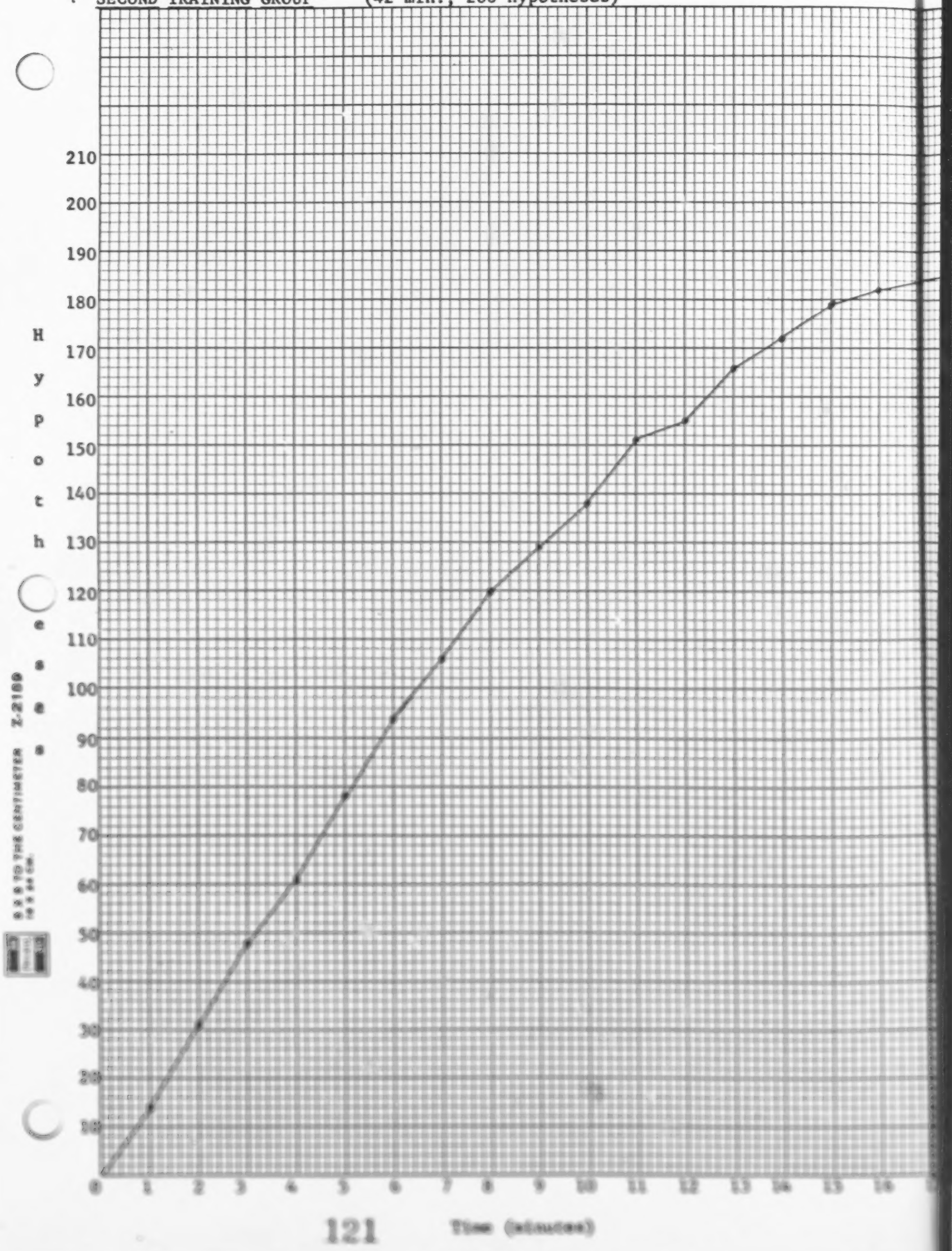
FIRST TRAINING GROUP

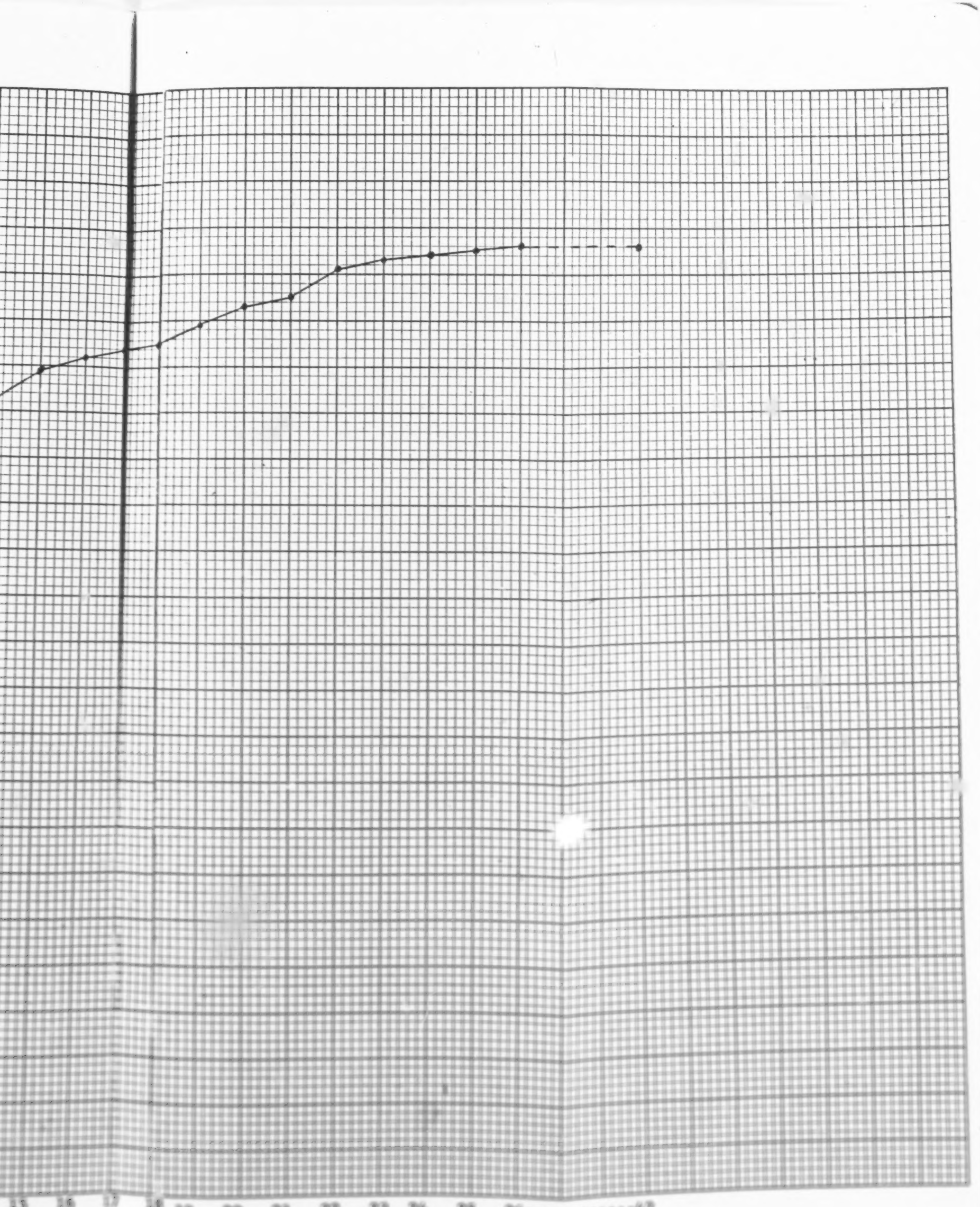
Minute Intervals

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1	2	1	1	2																			
3	1	2	1	2	2	1	2	5	-	-	3	-											
1	1	-	2	1	1	1	2	2	-	1	1	1	-	1	1	1	2	-	2	1	-	-	2
-	2	1	1	1	-	2	-	2	-	1	-	1	-	-	-	-	-	2	-	-	1	2	-
2	3	2	1	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
2	1	1	-	2	2	-	1	-	-	-													
1	1	1	2	-	1	1	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-		
1	2	-	1	1	1	1	1	-	-	-													
1	1	2	1	1	1	1	-	-	1	-	1	-	1	-	1	-							
12	14	10	10	11	9	10	7	9	1	2	5	3	1	1	2	2	2	2	2	1	1	2	
112	120	130	140	151	160	170	177	186	192	194	199	202	203	204	206	208	210	212	214	216	217	219	

24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	TOTAL HYPOTHESES
																			14
																			29
-																			40
1	-	1	1	1	2	-	2	1	-	-	2	1	-	-					37
1	-	-	-	-	-	2	-	-	1	2	-								22
-	-	-	-	-	-	-	-	-											20
																			16
1	-	-	-	1	-	-	-	-	-										12
																			14
-	1	-	1	-															18
3	1	1	2	2	2	2	2	1	1	2	2	1	-	-					222
203	204	205	207	209	211	213	215	216	217	219	221	223	225	227					222

HYPOTHESES: CUMULATIVE TOTALS BY TIME
SECOND TRAINING GROUP (42 min., 206 hypotheses)




19
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42

RECORDED HYPOTHESES BY TIME

SECOND TRAINING GROUP

NAME	Minute Intervals 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	2
Sherry	2	2	2	2	1	3	–	1	1	3	4	–	2	–	1	–	–	–	–	–
Toomey	2	0	1	1	4	1	2	1	1	2	1	–								
McTee	1	3	3	3	1	1	1	1	1	1	2	–	2	–	–	–	–	–	–	–
Wycislo	–	1	1	2	1	–	2	1	2	1	–	–	–	–	–	–	–	–	–	–
Trigg	–	2	1	–	1	2	3	3	1	–	1	2	2	1	1	–	–	–	1	–
Dvorak	3	4	4	3	4	3	1	4	1	–	–	–	4	2	1	1	2	–	1	
Tinley	1	1	2	–	1	2	1	3	1	–	–	–	–	1	2	1	–	–	–	
Morse	1	–	–	–	–	1	–	–	–	–	2	–	–	–	–	1	–	–	–	–
Rensford	2	3	2	0	2	2	1	–	–	1	2	–	1	2	2	–	–	1	2	–
Rankin	–	3	1	2	2	1	1	–	1	1	1	2	–	–						
TOTAL	12	19	17	13	17	16	12	14	9	9	13	4	11	6	7	3	2	1	4	
ACCUMULATED TOT.	12	31	48	61	78	94	106	120	129	138	151	155	166	172	179	182	184	185	189	

RECORDED HYPOTHESES BY TIME 124 125
SECOND TRAINING GROUP

Minute Intervals

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–						
–														•										
–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	2	2	2	1	1	1	–	–	–	–							
2	2	1	1	–	–	–	1	–	–	–	–	–	–											
–	4	2	1	1	2	–	1	1	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	1	2	1	–	–	–	1	–	1	–	–	–	1	–	–	–							
–	–	–	–	1	–	–	–	–	–	–	–	–	–											
–	1	2	2	–	–	1	2	–	–	1	–													
2	–	–																						
4	11	6	7	3	2	1	4	4	2	6	2	1	1	1	–	–	–	–	–	–	–	–	–	–
163	164	172	179	182	184	183	187	193	195	201	203	204	205	206	–	–	–	–	–	–	–	–	–	–

	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	TOTAL HYPOTHESES
34	—	—	—	—	—	—	—													
16			•																	
20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
20	1	1	—	—	—	—	—													
21			—																	
42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
19	—	—	1	—	—	—	—													
5	—	—																		
24																				
15																				
206	1	1		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
206	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

APPENDIX I

DATA SUMMARY

(1) Name of Trainee

(2) Grade Level of Pupils Taught

(3) Training Program

(4) Length of Sessions

(5) Number of Hypotheses

Observer #1
Observer #2
Observer #3

(6) Hypotheses Per Minute Based on Observer #1

(7) Cumulated Hypotheses Based on Observer #1

(8) Number of Intervals

(9) Number of Pupil Talk Intervals

(10) Number of Pupil Divergent Intervals

(11) Pupil Divergency as a Per cent of Pupil Talk

(12) Number of Hypotheses Per Pupil

Observer Number
Individual Pupils

(13) Attitude Scale

Pre-test
Post-test
Change

TRAINEE	GRADE TAUGHT	TRAINING PROGRAM	LENGTH OF SESSIONS (min.)	NUMBER OF HYPOTHESES			HPM Based on Obs. 1	Cum. Hyp. Obs. 1	NUMBER INTERV
				Obs. 1	Obs. 2	Obs. 3			
York, Susan	K	NT	13	13	13		1.0	13	226
Pitts, Cindy	3	NT	20	17	15		.85	17	400
Johnson, Helen	7	NT	12	7	6		.58	7	256
Wegner, Russ	10	NT	17	5	5		.29	5	330
Denker, Mary Ann	12	NT	23	16	16		.69	16	465
Anderson Barbara	K	NT	9	7	8		.78	7	148
Keller, Julie	3	NT	28	8	7		.29	8	627
Paulson, Linnae	7	NT	39	9	7		.23	8	722
Ahrens, Paul	10	NT	15	5	5		.34	5	285
Hout, Mary Lou	12	NT	10	4	3		.40	4	201
Faikus, Cheryl	K	1Tr	9	13	14		1.44	14	169
Steiner, Carol	3	1Tr	24	40	39		1.65	40	491
Hoffman, Philip	7	1Tr	35	23	22		.66	22	635
Dame, Charles	10	1Tr	22	16	17		.73	16	431
Whisker, Doug	12	1Tr	22	14	13		.64	14	466
Hagensick, Jeanne	K	1Tr	16	29	28		1.81	29	329
Corry, Juanita	3	1Tr	38	36	37		.95	37	715
Dietel, Greg	7	1Tr	32	21	18		.66	20	582
Nelson, Dan	10	1Tr	33	14	13		.42	12	612
Veach, Helen	12	1Tr	28	18	15		.64	18	544
Sherry, Barbara	K	2Tr	30	25		24	.83	27	592
Toomey, Maureen	K	2Tr	12	16		16	1.33	16	234
McTee, Richard	3	2Tr	37	19		20	.51	20	740
Wycislo, Linda	3	2Tr	29	21		20	.73	20	575
Trigg, Betty	7	2Tr	25	20		22	.80	21	497
Dvorak, Christine	7	2Tr	42	45		42	1.07	42	821
Tinley, Candy	10	2Tr	29	19		17	.66	19	580
Moran, Pat	10	2Tr	25	9		5	.36	5	434
Lunsford, Betty	12	2Tr	23	24		23	1.04	24	433
Lenkin, Rita	12	2Tr	14	15		15	1.07	15	281

UMBER OF PUPIL TALK NTERVALS	NUMBER OF PUPIL DIV. INTERVALS	PUPIL DIV. AS % OF PUPIL TALK	NUMBER OF HYPOTHESES PER PUPIL							ATTITUDE SCALE		
			Obs.	Pupils 1	2	3	4	5	6	PRE-TEST	POST-TEST	CHANGE
99	36	36	(1)	4	2	1	4	2		413	411	- 2
210	40	19	(1)	5	2	2	2	6		328	340	+12
138	7	5	(1)	1	2	0	2	2		420	409	-11
190	59	31	(1)	2	1	2	0	0		377	374	- 3
351	91	26	(1)	2	4	4	5			371	366	- 5
40	7	18	(1)	1	1	2	2	1		320	320	0
475	31	7	(1)	1	4	2	1	0		347	347	0
565	15	3	(1)	3	0	3	2	1		369	357	-12
175	13	7	(1)	1	3	0	1	0		376	363	-13
95	7	7	(1)	0	0	2	0	2		367	372	+ 5
61	43	70	(1)	5	1	0	3	4		392	393	+ 1
293	173	59	(1)	9	9	8	6	8		340	356	+16
391	132	34	(1)	7	4	7	3	2		336	347	+11
214	99	46	(1)	2	4	3	6	1		387	376	-11
302	72	24	(1)	5	3	4	2			391	448	+57
123	92	75	(1)	0	8	12	2	7		355	400	+45
519	426	82	(1)	12	7	12	5			341	325	-16
318	257	81	(1)	6	7	6	2			346	368	+22
149	30	20	(1)	4	6	0	3	1		366	371	+ 5
379	130	34	(1)	4	7	1	2	4		371	495	+124
329	46	14	(1) (3)	4 3	5 9	3 1	7 6	6 5		361	352	- 9
61	27	44	(1) (3)	0 0	2 2	6 6	1 0	7 8		388	355	-33
428	65	15	(1) (3)	7 5	4 5	1 0	6 8	1 2		339	392	+53
366	57	16	(1) (3)	3 3	4 4	5 5	4 4	5 4		363	397	+34
238	77	32	(1) (3)	7 11	12 10	0 0	1 1	0 0		350	363	+12
670	210	31	(1) (3)	7 6	12 11	15 14	3 3	8 8		390	396	- 4
431	116	27	(1) (3)	1 2	6 5	1 1	1 1	7 6	3 2	381	364	-17
265	22	8	(1) (3)	0 0	1 0	1 1	3 2	4 2		331	339	+ 8
212	54	25	(1) (3)	0 0	3 2	6 6	0 0	9 9	6 6	338	369	+31
86	34	40	(1) (3)	1 0	3 3	2 1	4 4	5 7		365	353	-12

APPENDIX J

OUTLINE OF FIRST TRAINING PROGRAM

(1) Topical Outline

(2) Basic Points

(3) Leader's Guide

(4) Instructor-Trainee Roles in Training Sessions

TOPICAL OUTLINE: FIRST TRAINING PROGRAM (HANDOUT)

(1) Information, directions and assignments

- (a) Pre-test (attitude)
- (b) Data about training and teaching sessions
- (c) Data about school subjects (general)
- (d) Data about micro-session arrangements (physical)

(2) Nature of creative problems

- (a) Definition of problem
- (b) Data about problem
- (c) Problem solving schema
- (d) Problem reduction

(3) Terminology

- (a) Cognitive-memory
- (b) Convergent thinking
- (c) Divergent thinking
- (d) Evaluative thinking
- (e) Hypothesis--copious ideation

(4) Direction giving

- (a) Clarity and explicitness
- (b) Logical organization
- (c) Probing for feedback
- (d) Exmaples

(5) Student initiated talk and interaction

- (a) Divergent talk
- (b) Divergent verbal interaction
- (c) Probing for hypotheses

(6) Judicious use of silence

- (a) Silence as a technique
- (b) Other non-verbal behaviors

(7) Avoidance of excessive evaluation

- (a) Results of excessive teacher evaluation
- (b) Results of excessive student evaluation

(8) Sensitization experience

- (a) Relevant problem
- (b) Alternative problems
- (c) Evaluation of sensitivity session

(9) Phrasing of divergent questions

(a) Questions for initiating divergency
(b) Questions for probing divergencies

(10) Culminating activities

(a) Micro-teaching session
(b) Post-test (attitude)

BASIC POINTS: FIRST TRAINING PROGRAM (HANDOUT)

Key Term or Phrase

(1) DEFINITION (of problem)

(2) ADEQUATE DATA

(3) CLARIFY PROBLEM (as needed)

(4) RELATE problem to pupil experience

(5) CLEAR DIRECTIONS (on procedures, approach, etc.)

(6) MULTIPLE HYPOTHESES (type of divergency sought)

(7) PROBLEM REDUCTION (reduce problematic field)

(8) DIVERGENT QUESTIONS (by teacher)

(9) STUDENT TALK (and interaction)

(10) PROBING (by teacher)

(11) SILENCE (judicious use thereof)

(12) Avoid excessive EVALUATION

LEADERS' GUIDE

FIRST TRAINING PROGRAM

-Creativity Project-

Program Content	Program Procedures
I. Information, directions and assignments	
A. Pre-test: Rumery, Pupil Behavior Opinion Survey	·Administer pre-test: Trainee to read directions on first page. Instructor available for questions as needed.
B. Date, time, etc. for training sessions and micro-teaching sessions	·Three one and one-half hour training sessions within one week period. One micro-teaching session (video-taped) Time est.: 20-40 minutes.
C. Names of school students (K/3/7/10/12 from Lab Schools)	·Five school students at each of the five grade levels. Representative sample in terms of creativity scores (Torrance Test).
D. Micro-teaching session arrangements	·Videotaping of session, about 20-40 minutes in length (5 school students and one Junior Participant per grade level, K/3/7/10/12).
E. Reading assignments: 1. The Logical Operations of Thinking (pages 24-27, 29-31 from James J. Gallagher, Productive Thinking of Gifted Children. Cooperative Research Project No. 965, 1965).	·Assigned for second training session
2. Outline for first training program for Junior Participants (handout)	·To be used as study guide for training sessions.
II. Nature of the problem (for micro-sessions	
A. Defining the problem: The group is to assume that they have arrived by space-ship on a planet like earth and are to settle permanently on the planet. They are responsible for suggesting ideas about the educational system for the new settlement. Specifically--What type of educational system would you construct?	·Discuss presentation of problem. Solicit questions. Mention importance of problem clarity before problem solving process can proceed.
B. Necessary data about the problem area: The planet where the group is to settle is quite similar to earth. The climate is temperate and the soil is fairly good by earth standards. The group is	·Discuss presentation of data. Solicit questions. Mention importance of supplying sufficient data about problem so that participants know the boundaries of the problematic situation--what is possible and what is not possible.

Program Content	Program Procedures
made up of a mixture of Americans--young and old, assorted social backgrounds, various occupations, etc. Basic tools and supplies were brought with the group on the spaceship. The group cannot communicate with earth, nor is return to earth possible.	
C. Problem solving schema (logic or structure of the problem solving process):	
1. Student understanding of the problem (clarity in terms of definition, data, etc.)	·This is the first step. Mention that the problem solving process cannot proceed effectively until such clarity is achieved.
2. Student relating problem to own experience and viewing the problem as a real problem for him	·This is the second step. Mention importance of student coming to view the problem as something that is real for him. Pull in student experiences that have a direct bearing on the problem at hand.
3. Generation of hypotheses	
a. Goal of multiple hypotheses	·Mention importance of obtaining large quantity and variety of hypotheses.
b. Probing for meaning of each hypothesis	·Mention importance of probing to ascertain what participants conceive would be accomplished by hypotheses offered.
c. Probing for elaboration of hypotheses offered.	·Mention importance of probing in an effort to get participants to add to, or improve various hypotheses offered.
D. Problem reduction: Reduction of the problematic field using examples that students can understand and relate to. Zero in on specific areas.	·Example of problem reduction: such as in dealing with the problem of teenage crime, where specific instances might be considered (e.g., shoplifting in variety store, vandalism, robbing a service station, etc.)
III. Terminology: Intensional and extensional definitions of concepts	
A. Cognitive-Memory B. Convergent Thinking C. Divergent Thinking D. Evaluative Thinking E. Hypothesis--copious ideation	·Go over definitions and examples included in hand-out on Logical Operations of Thinking. Emphasize hypothesizing operations in divergent category. Solicit student "translations" of definitions. Offer and solicit additional examples of each type of operation. Use Teenage Crime as exemplar problem in citing examples, etc. Discuss distinctions between four types of thinking with emphasis on being able to identify divergency (and hypothesizing as the type of divergency most sought.....).

Program Content	Program Procedures
IV. Direction giving....	
A. Clarity and explicitness of language	·Mention importance of clear directions, etc. so that students will be aware of what is expected of them in the problem solving process. Observe and solicit feedback from students regarding directions.
B. Logical organization	
C. Probing for student reaction and feedback	
D. Examples of adequate directions	·Instructor provide set of directions on a topic on which he is well informed. Have trainees give set of directions on topic on which they are well informed.
1. Instructor examples 2. Trainee examples	
V. Student initiated talk and interaction	
A. Nature of student divergent talk	·Examples of divergent talk and interaction using examples from problem of Teenage Crime. Discuss other examples using a different problem as the base. Encourage interaction!
B. Nature of divergent verbal interaction between students	
C. Role of teacher in guiding interaction--probing for hypotheses	·Examples of probing questions as a means of guiding thought (see examples in IX below)
VI. Judicious use of silence	
A. Silence for think-time after question or comments	·Examples of calculated pauses. Students need time to think!
B. Noting various forms of non-verbal behavior	·Examples of significant non-verbal behaviors on part of teacher and students
VII. Avoidance of excessive evaluation	
A. Frequent results of excessive teacher evaluation of student	·Examples from research. Examples based on problem of Teenage Crime.
B. Frequent results of excessive student evaluation of other student	·Same as above. ·Review difference between divergent and evaluation categories.
VIII. Sensitization: Creative Problem Solving Experience	
A. Problem for use in problem solving experience: Radical groups on campus	·Sensitize trainees to idea of creative behavior by subjecting them to a creative problem solving experience. Employ steps, procedures, etc., included in various training sessions.
B. Possible alternative problems: 1. Voting 2. Dormitory visitation and hours 3. Community-University relations 4. Drugs	·Trainer to act as teacher; trainees to act as students.

Program Content	Program Procedures
C. Evaluation of sensitivity session (in terms of behaviors, steps, etc., included in training sessions).	·Carefully review all aspects of session. Discuss results and how participants viewed the on-going experience....
IX. Phrasing of divergent questions	
A. Basic divergent facilitating questions	·Examples that apply in facilitating hypotheses
B. Questions for probing further	·Examples that apply in probing
C. Suggested starters:	
1. Suppose..., then what?... 2. How might you go about...?... 3. What if...?... 4. What would you do...?... 5. What are some ways of...?... 6. How would you change...?... 7. What else would you add to that idea...?...	·Solicit other examples from trainees ·Ask to recall examples from sensitivity session
X. Culminating activities	
A. Micro-teaching session (Time est.: 20-40 minutes)	
B. Administration of post-test (Rumery, Pupil Behavior Opinion Survey)	

NOTE: Time of various sessions, etc.

1st training session: Items I and II above (1½ hours)

2nd training session: Items III through VII above (1½ hours)

3rd training session: Items VIII and IX above (1½ hours)

Micro-teaching session: (Time est.: 20-40 minutes)

Post-test: Administered soon after micro-teaching session

INSTRUCTOR-TRAINEE ROLES IN TRAINING SESSIONS

(Time: 4½ hours, not including pre- and post-tests or micro-teaching sessions)

	Role	Est. % of Time
Instructor:	Exposition	25
	Role Playing	15
	Providing Examples	10
Trainee:	Questions (informational)	10
	Role Playing (convergent-divergent)	15
	Suggesting Examples (convergent)	10
	Recitation (cognitive-memory)	15
		100

APPENDIX K

OUTLINE OF SECOND TRAINING PROGRAM

(1) Figural Summary of Second Training Program

(2) Table of Contents (of Second Training Program)

(3) Climate Guidelines

(4) Overview of Brainstorming Hypotheses Procedures

(5) Summary of Brainstorming Hypotheses Procedures

(6) Summary of Transformation Activities

TABLE OF CONTENTS

Outline Section

1.0 Locating teacher trainees

4.0 Training session

4.1 Overview of project and trainee role in project

4.2 Climate guidelines for creative problem solving sessions

4.3 Creative problem-solving encounter

4.4 Process analysis

4.5 Summary of program

4.6 Examination of pupil materials

5.0 Involve trainee in using Divergent Transformation activities with pupils

6.0 Involve trainee in Brainstorming Hypothesis with pupils and self-evaluation of video-tape

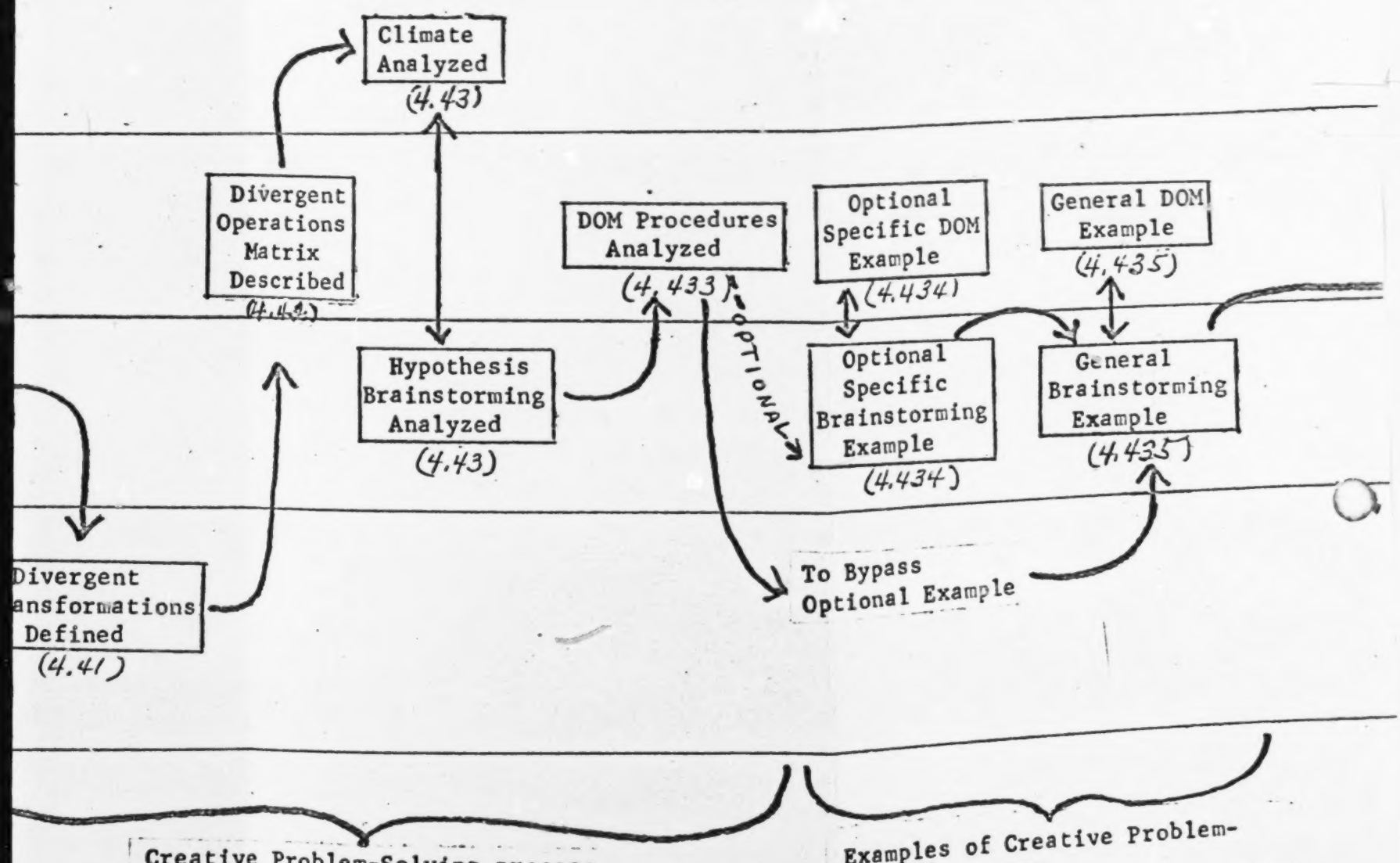
7.0 Repeat Brainstorming Hypothesis sessions until specified level and pattern of pupil hypothesizing is achieved

8.0 Hypothesizing in perspective

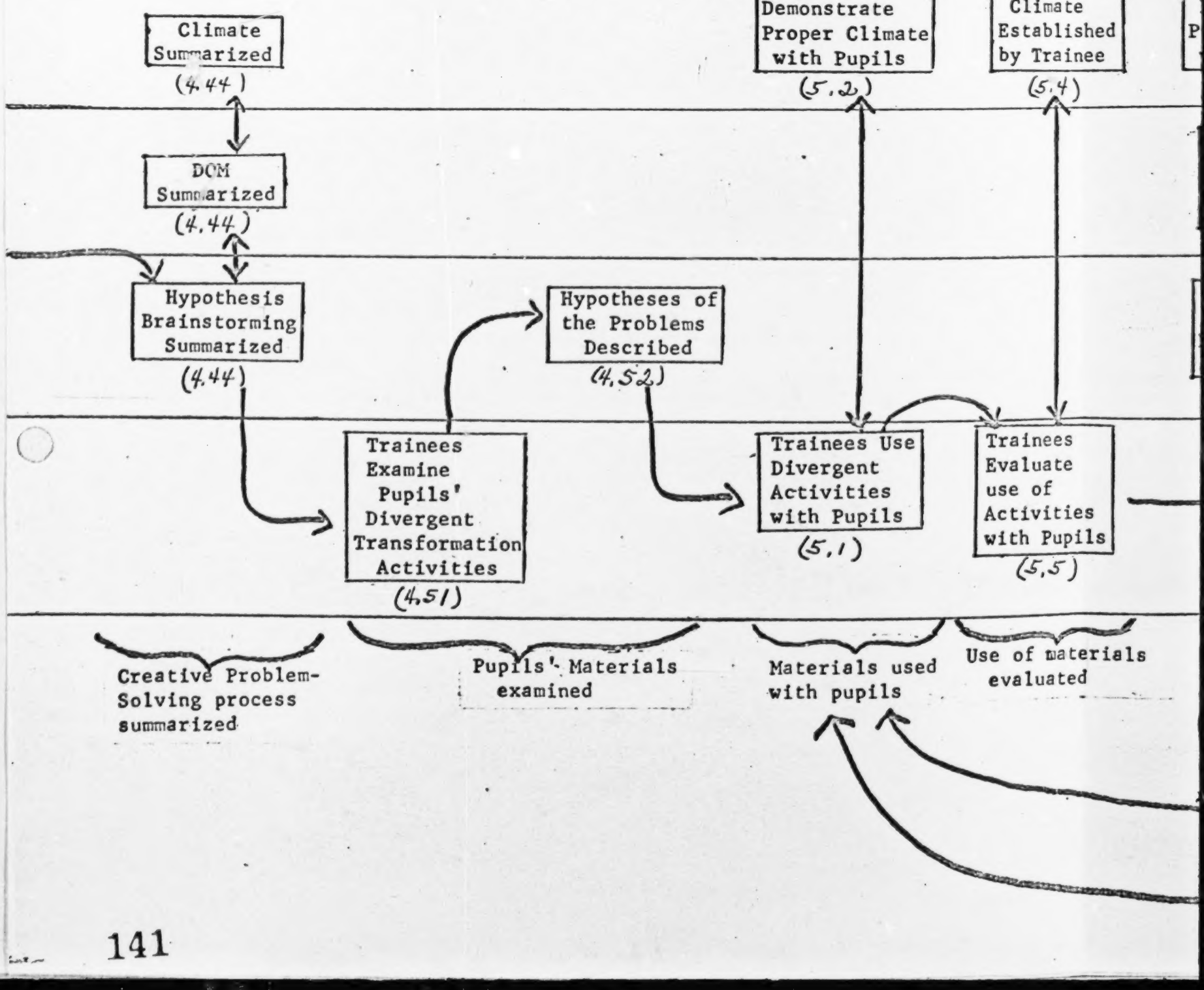
Time
Overview of Project
(4.1)
(video taped)
(vid
(pl
Elements
Classroom Climate
Climate Described
(4.21)
Climate Exemplified
(4.31)
Climate Exemplified
(4.32)
Cl
Ar
Divergent Operations Matrix
Divergent Operations Matrix Described
(4.42)
Hypothesis Brainstorming
Hypothesis Brainstorming with Trainee
(4.32)
Bra
A
Divergent Transformation Activities
Divergent Activities used with Trainee
(4.31)
Divergent Transformations Defined
(4.41)
Trainees experience Creative Problem-solving and Divergent Activities led by instructor
Creative Problem-S
defined, described

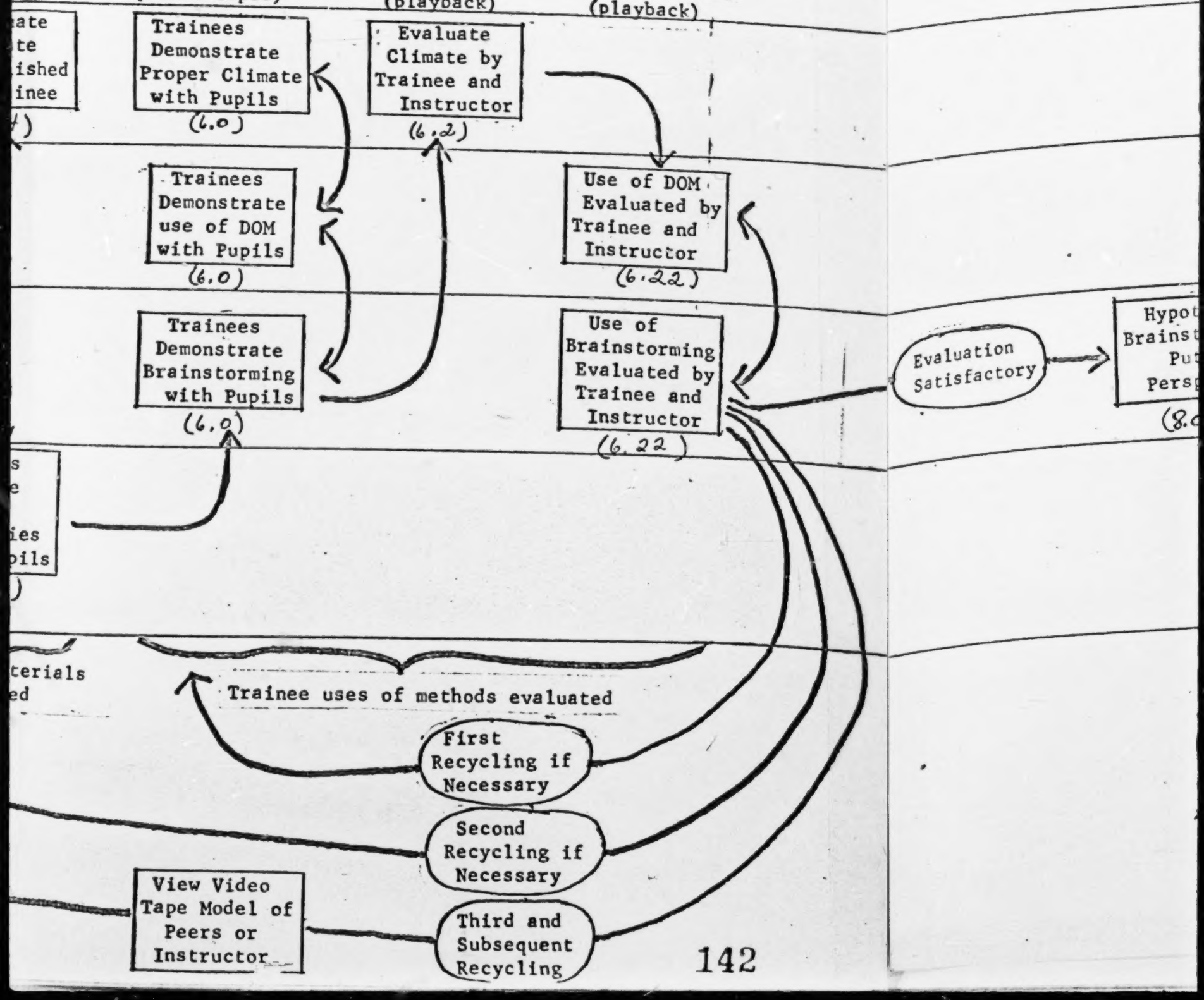
(video tape) (playback)

(video tape) (playback)



8.3 Figural Summary of the Creative Problem Solving Training Program


(1st Micro-Teaching)
(Session)
(2nd
Climate Summarized (4.44)
Trainees Demonstrate Proper Climate with Pupils (5.2)
Evaluate Climate Established by Trainee (5.4)
DCM Summarized (4.44)
Hypothesis Brainstorming Summarized (4.44)
Hypotheses of the Problems Described (4.52)
Trainees Examine Pupils' Divergent Transformation Activities (4.51)
Trainees Use Divergent Activities with Pupils (5.1)
Trainees Evaluate use of Activities with Pupils (5.5)
Creative Problem-Solving process summarized
Pupils' Materials examined
Materials used with pupils
Use of materials evaluated


(2nd Micro Session)
(video taped)
(1st video tape)
(playback)
(2nd video tape)
(playback)
Trainees Demonstrate Proper Climate with Pupils
(6.0)
Evaluate Climate by Trainee and Instructor
(6.2)
Trainees Demonstrate use of DOM with Pupils
(6.0)
Use of DOM Evaluated by Trainee and Instructor
(6.22)
Trainees Demonstrate Brainstorming with Pupils
(6.0)
Use of Brainstorming Evaluated by Trainee and Instructor
(6.22)
Evaluation Satisfactory
Trainee uses of methods evaluated
First Recycling if Necessary
Second Recycling if Necessary
Third and Subsequent Recycling
View Video Tape Model of Peers or Instructor

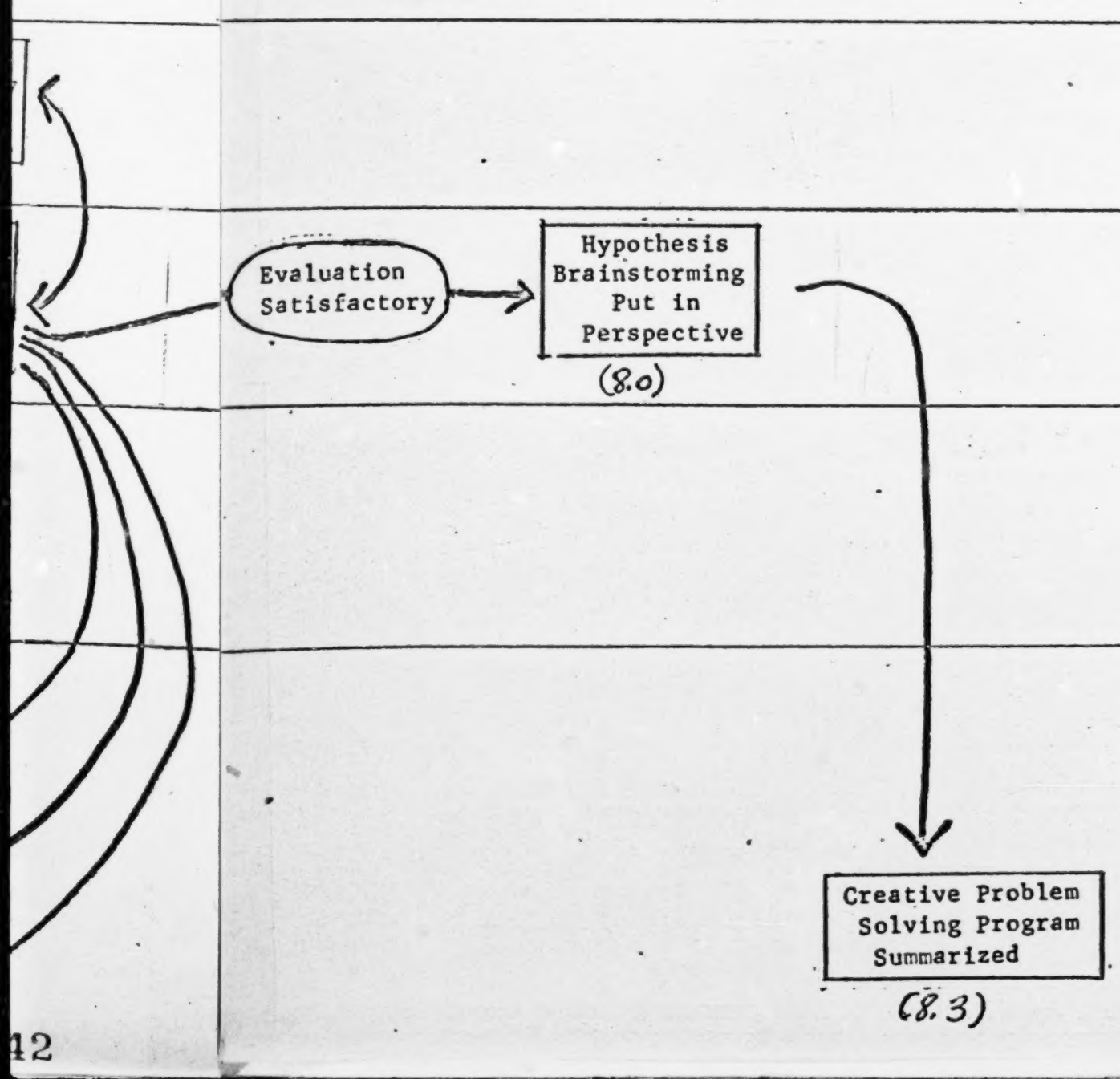
e)

Classroom Climate

Divergent Operations Matrix

Hypothesis Brainstorming

Divergent Transformation Activities



42

4.2 Climate guidelines for creative problem solving sessions

4.21 Climate handout (see attachment)

4.22 Topical summary of climate guidelines

(Solicit trainee interpretation of meaning for each of the eight categories and provide brief trainer interpretation of intended meaning)

Category	Recommendation
4.221 Student Talk--Quantity:	TURN THEM ON! (with volume up)
4.222 Teacher Talk--Phrasing:	QUESTION!....Probe! Probe! Probe!
4.223 Silence:	SHUT UP SOME OF THE TIME! (this means you!)
4.224 Student Talk--Dispersion:	INVOLVE MOST PUPILS! (all if possible!)
4.225 Evaluation:	JUDGE NOT!....Accept! Accept! Accept!
4.226 Respect:	RESPECT RESPONSES! (kids are people too!)
4.227 Feedback Sensitivity:	STOP - LOOK - LISTEN!....Relate!
4.228 Student Talk--Ideas:	PICK THEIR BRAINS!....Divergencies!

4.23 Basic presentation of climate guidelines

(Discuss each of the eight categories with appropriate examples from printed outline, trainee, and instructor (trainer))

4.231 Student Talk--Quantity. Teacher should stimulate and facilitate a large volume of problem-related student talk and interaction. Spin-off student initiated talk and interaction should not be discouraged.

4.232 Teacher Talk--Phrasing. Teacher should carefully phrase and rephrase communications with pupils in an effort to be precise, direct, clear and brief. Particular attention should be given to questions designed to elicit and/or probe pupil divergent responses. Teacher communications which are likely to facilitate creative responses can be classified as follows:

4.2321 Teacher questions and rephrasing designed to elicit divergent solutions (hypothesis)

How might one go about remedying this....?
What are some possible ways of.....?
What might be changed in order to.....?
What would you do.....?
What might be added or subtracted that would help.....?
Is there any other way of.....?
Assume that it is up to you to.....?

4.2322 Teacher questions and rephrasing designed to reduce and clarify the problematic field (a strategy which often can be useful when questions as suggested in "a" above are non-productive)

4.23221 Questions and rephrasing designed to direct attention of pupils to specific causal elements of the problem. (Example: What is an important factor that contributes to the existence of this problem.....? .....What might be done about it.....?)

4.23222 Questions and rephrasing designed to direct attention of pupils to a specific situation or circumstance where the problem exists. (Example: Assume that you are in situation "X" and that the problem came into existence in the form of "Y." What might be done in this situation.....?)

4.2323 Teacher questions and rephrasing designed to probe and clarify solutions (hypotheses) offered

What else might be added to that idea?
Yes, go on.....
Who else can add to that.....?
Does that suggest anything else to any of you.....?
Repeat that again slowly..... Let's think about it for a moment.....
Okay, that's interesting..... What else.....?
Now we're moving! Let's pursue that some more..... OK?
Anything that strikes you! Come on, let your thoughts flow out.....!.....
Here's an idea of mine;..... Does that suggest anything to you.....?

4.233 Silence. Teacher should remain silent for a period of time after most of his questions (and comments) in order to give pupils time to think before responding. Also, he should not try to fill all of the periods of silence after students' ideas are presented (brief incubation periods can be productive.)

4.234 Student Talk--Dispersion. Teacher should employ a strategy for recognizing pupil volunteers which will give first priority to pupils who talk least.

4.235 Evaluation. Teacher should avoid evaluating pupil responses (ideas, etc.) and should tactfully discourage pupil evaluation of the ideas of their peers (deferred judgment).

4.236 Respect. Teacher should, by means of a variety of verbal and non-verbal behaviors, give evidence of an attitude of respect for pupil comments, questions, and ideas.

4.237 Feedback Sensitivity. Teacher should make a conscious effort to be sensitive to all kinds of feedback from pupils. In addition to verbal feedback, the teacher should be sensitive to student non-verbal communications such as restlessness, vocal inflections, gestures, facial expressions, etc. A teacher should be concerned with such non-verbal communications directed toward him or directed toward other students. Feedback sensitivity should alert the teacher to changes in student needs, perceptions and understanding and should guide the student in modifying his behavior.

4.238 Student Talk--Ideas. Teacher should stimulate and facilitate a large variety of ideas (multiple hypotheses) related to the problem.

Overview of Brainstorming Hypotheses Procedures

The Climate

Note: Supportive atmosphere established and maintained throughout.

The Problem

Note: Specific problem clearly described.

The Brainstorming Procedure

Note: Multiple hypotheses (solutions) solicited.

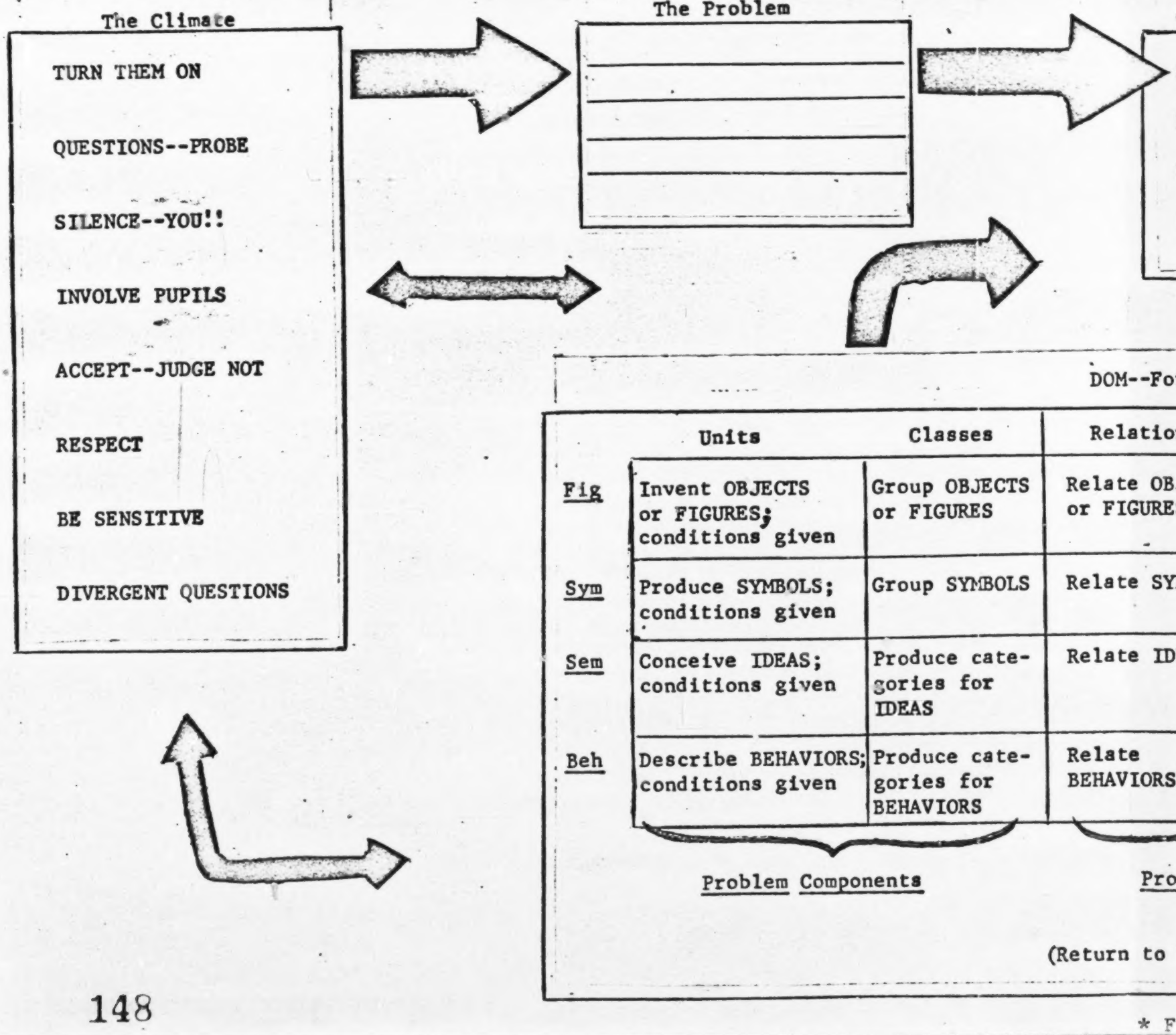
Divergent Excursions undertaken when hypotheses are no longer forthcoming.

DIVERGENT OPERATIONS MATRIX (DOM)--For Divergent Excursions

	U	C	R	S	T	I
Fig	Note: A Divergent Excursion is a type of questioning strategy designed to:					
Sym	(a) Maintain focus on various aspects of the problem,					
	(b) Stimulate divergent-type thought related to the problem, and					
Sem	(c) Kindle the generation of additional hypotheses (solutions)					
Beh						

Note: Divergent Excursions should be terminated as soon as practical and brainstorming hypotheses resumed.....

4.321 Summary of Hypothesis Brainstorming Procedures



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em

The Brainstorming Procedure

SEEK HYPOTHESIS

EXTEND HYPOTHESIS

LIST HYPOTHESIS

USE DOM FOR DIVERGENT EXCURSIONS

DOM--For Divergent Excursions

	Classes	Relations	Systems	Transformations	Implications*
CTS given	Group OBJECTS or FIGURES	Relate OBJECTS or FIGURES	Composites of OBJECTS or FIGURES	New configurations for OBJECTS or FIGURES	Elaborate an OBJECT or FIGURE
BOLS; given	Group SYMBOLS	Relate SYMBOLS	Composites of SYMBOLS	New meaning for SYMBOLS	Implications of SYMBOLS
EAS; given	Produce categories for IDEAS	Relate IDEAS	Describe complex IDEAS	IDEAS involving reinterpretation of object or situation	Consequents of IDEAS
HAVIORS; given	Produce categories for BEHAVIORS	Relate BEHAVIORS	Organize BEHAVIORS	Convert stimuli to BEHAVIORS	Consequents of BEHAVIORS

This Way Next

m Components — Problem Causation — Problem Analogy — Problem consequences

(Return to Brainstorming as Soon as Practicable)

* From J. P. Guilford's Structure-of-Intellect

4.513 Summary of Transformation Activities
(kindergarten through adult)

Figural (A collection of objects which can be assembled in a variety of ways)--Students are instructed to assemble the objects in different or unusual ways or to invent new uses for the objects.

Symbolic (A page with directions, examples and given words is provided)--The students are asked to assemble lists of words in which each word is identical with the previous word in the list except that one letter is altered (a letter added, a letter omitted or a letter substituted). Emphasis should be on length of list (no words repeated) or longest word generated. The words must be real words.

Semantic (A piece of paper which emits a scent)--The students are asked to record in writing (verbally in lower grades) the unusual impression or feeling which results from encountering the scent.

Behavioral (A variety of unusual hats)--Students are asked to describe their feelings about a person as a result of his wearing a specific hat.

APPENDIX L

OUTLINE OF THIRD TRAINING PROGRAM*

(1) Figural Summary of the Creative Hypothesizing Training Program

(2) Table of Contents (of Third Training Program)

(3) Overview of Brainstorming Hypotheses Procedures

(4) Summary of Brainstorming Hypotheses Procedures

(5) Summary of Transformation Activities

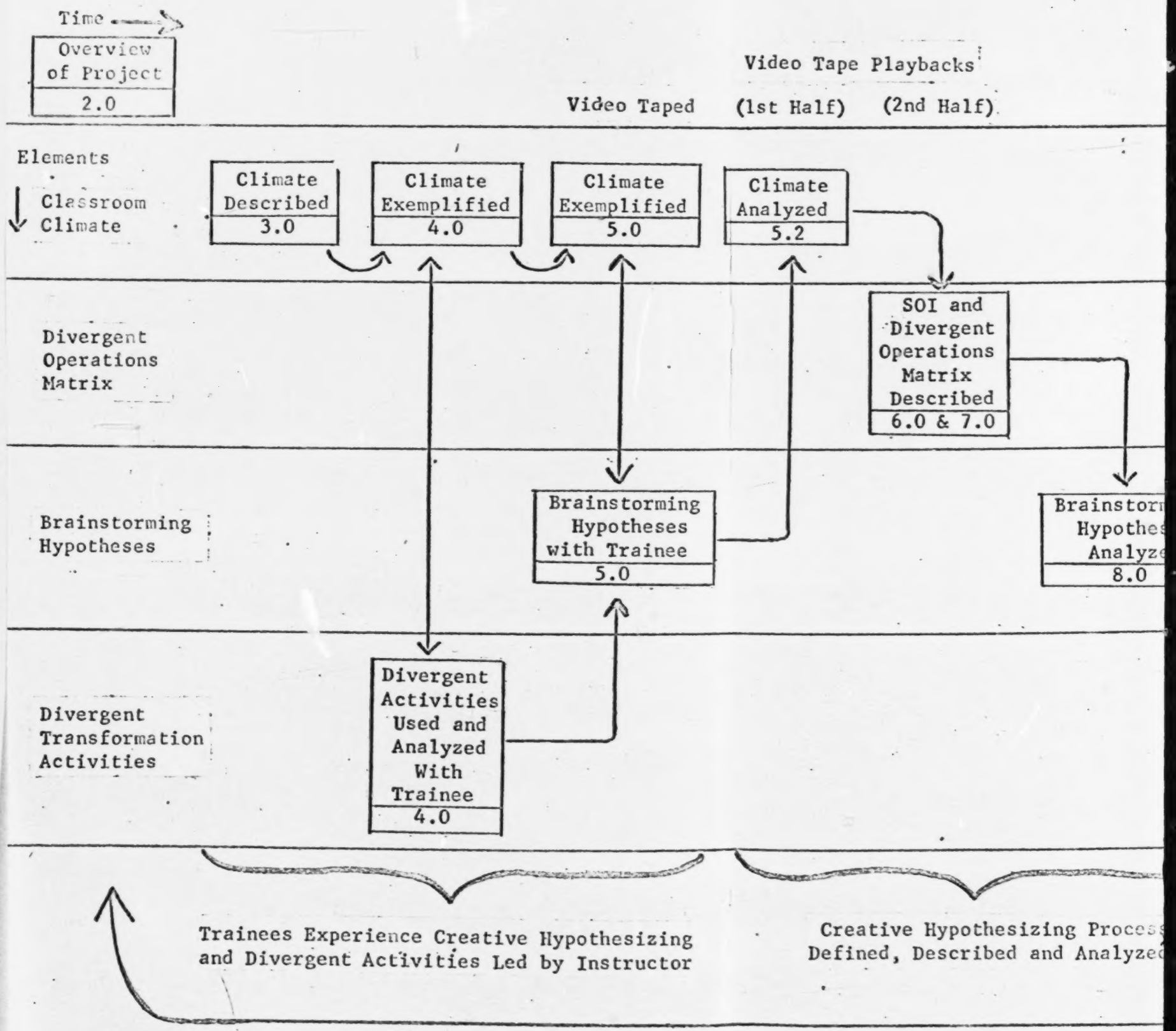
(6) Description of Structure-of-Intellect

(7) Guidelines for Identifying Hypotheses

(8) Time-Quantity Analysis of Hypotheses Graph (With Minimum Performance Line)

*The program is entitled, Instructional Strategies for Creative Hypothesizing: A Training Program. The complete training program is included in the following:
(a) Leaders' Syllabus (loose-leaf notebook)
(b) Trainee Materials (loose-leaf notebook)
(c) Set of Divergent Transformation Activities (boxed)

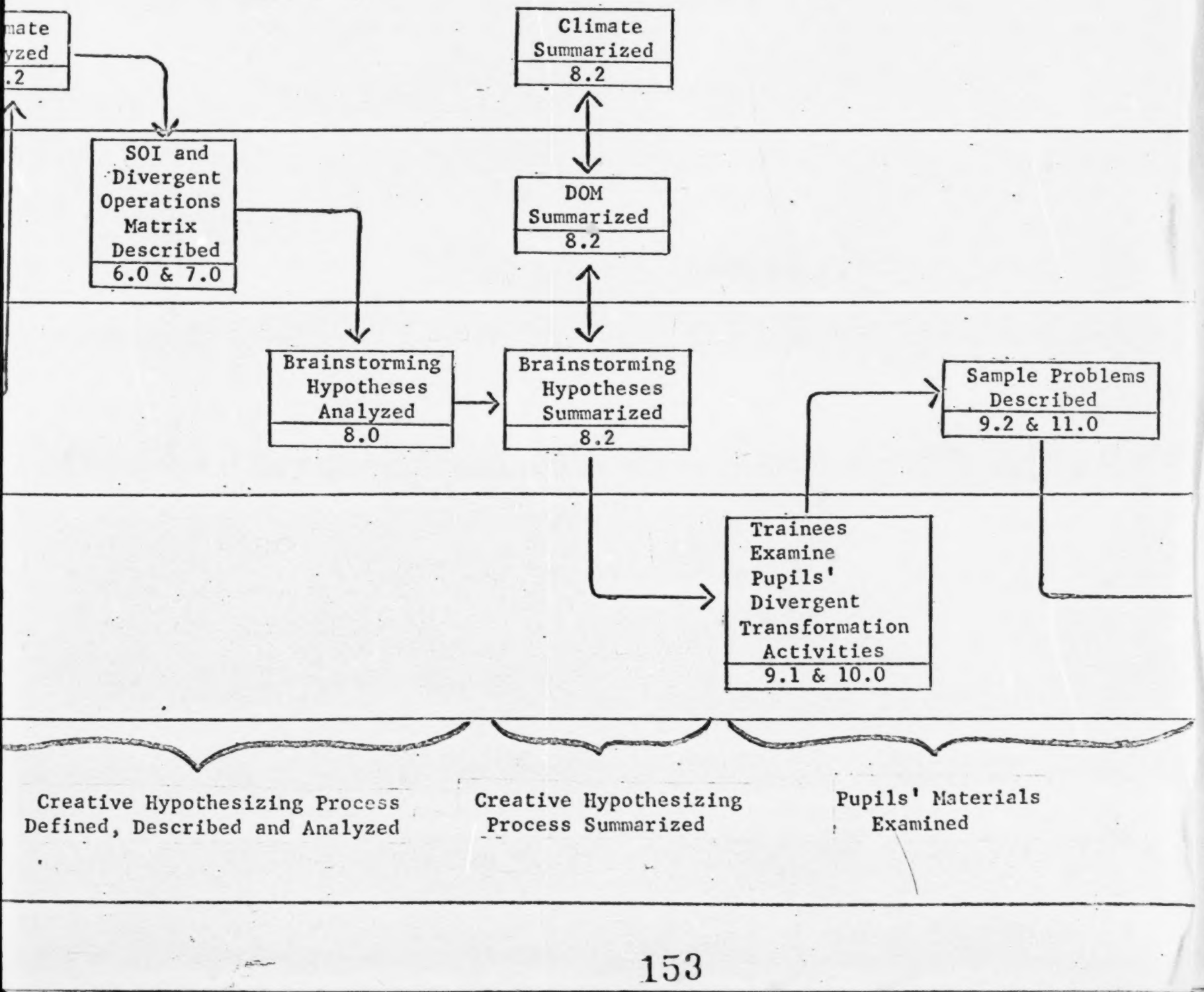
13.3 Figural Summary of the Creative Hypothesizing Training Program



eo Tape Playbacks

Half) (2nd Half)

Video Tape Playback
(entire tape)



1st Micro-Teaching Session

2nd Micro-Teaching Session (video taped)

Trainees Demonstrate and Evaluate Proper Climate With Pupils
10.0

Trainees Demonstrate and Evaluate Proper Climate With Pupils
11.2

Trainees Demonstrate and Evaluate Use of DOM With Pupils
11.3

Trainees Demonstrate and Evaluate Brainstorming Hypotheses With Pupils
11.4

Eval Satis

Eval Unsati

Trainees Demonstrate and Evaluate Use of Divergent Activities With Pupils
10.0

Materials Used and Evaluated With Pupils

First Recycling

Second Recycling

Third Recycling

Fourth and Subsequent Recycling

Examine Di
12.11

View Vid
1

View Vide of Peers

Classroom Climate

Divergent Operations Matrix

Brainstorming Hypotheses

Divergent Transformation Activities

Evaluation Satisfactory

Evaluation Unsatisfactory

Brainstorming Hypotheses Put in Perspective
13.1

Recycle

Examine Diagnostic Graphs
12.11a-12.11h

First Recycling

View Video Tape Again
11.0

View Video Tape Model of Peers or Instructor

Creative Hypothesizing Training Program Summarized
13.2

TABLE OF CONTENTS: LEADER'S SYLLABUS

Outline Section

Introduction

1.0 General Information for Trainees

2.0 Overview of Training Program and Description of Trainee Involvement

3.0 Climate Guidelines for Creative Problem Solving

4.0 Divergent Transformation--Practice and Analysis

5.0 Brainstorming Hypotheses Practice--Analysis of Climate

6.0 Description of Structure-of-Intellect

7.0 Provide Trainees with Divergent Operations Matrix (DOM), and Consider Directions in Each Cell

8.0 Generating Hypotheses

9.0 Examination of Pupil Materials

10.0 Description of Involvement of Trainees with Pupils (in micro-type groups): Including Use of Divergent Transformation Activities and Evaluation of Performance

11.0 Description of Involvement of Trainees with Pupils (in micro-type groups): Including Application of Brainstorming Hypotheses Procedures and Evaluation of Performance

12.0 Recycling Procedures

13.0 Hypothesizing in Perspective

References

Appendix

Overview of Brainstorming Hypotheses Procedures

The Climate

Note: Supportive atmosphere established and maintained throughout.

The Problem

Note: Specific problem clearly described.

The Brainstorming Procedure

Note: Multiple hypotheses (solutions) solicited.

Divergent Excursions undertaken when hypotheses are no longer forthcoming.

DIVERGENT OPERATIONS MATRIX (DOM)--For Divergent Excursions

	U	C	R	S	T	I
Fig	Note: A Divergent Excursion is a type of questioning strategy designed to:					
Sym	(a) Maintain focus on various aspects of the problem,					
	(b) Stimulate divergent-type thought related to the problem, and					
Sem	(c) Kindle the generation of additional hypotheses (solutions)					
Beh						

Note: Divergent Excursions should be terminated as soon as practical and brainstorming hypotheses resumed.....

13.2 Summary of Brainstorming Hypotheses Procedures (Generalized for most problems)

The Climate

Teacher--DIVERGENT QUESTION

Teacher--PROBE FOR DIVERGENCIES

Teacher--ACCEPTANCE/RESPECT

Teacher--SILENCE

Teacher--FEEDBACK SENSITIVITY

Pupil Talk--QUANTITY

Pupil Talk--DISPERSION

Pupil Talk--DIVERGENT

The Problem

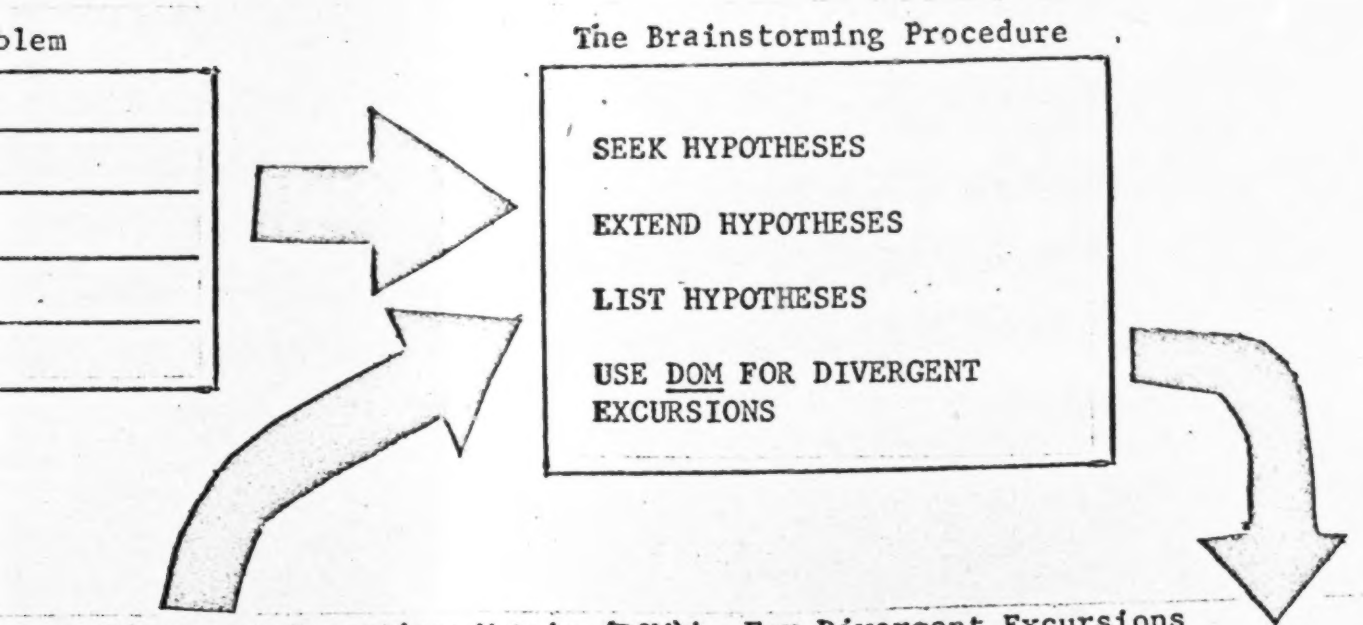
Divergent Operations Ma

	Units	Classes	Relations
Fig	Produce figures conforming to simple specifications.	Group figures in different ways.	Generate re tionships between fig
Sym	Produce symbols which conform to simple specifications.	Group symbols in different ways.	Relate sym in differe ways.
Sem	Produce elementary ideas appropriate to given requirements.	Produce categories of ideas.	Produce re tionships tween idea
Beh	Produce elementary behaviors conforming to simple specifications.	Produce categories of behavior.	Generate re tions betw given beha

(Return to B

*J. P. Guilford, "Three Faces of Intellect," American Psychologist, vol. 14, no. 8 (August, 1959), pp. 469-479.

d for most problems)



Divergent Operations Matrix (DOM)*--For Divergent Excursions

	Classes	Relations	Systems	Transformations	Implications*
a-	Group figures in different ways.	Generate relationships between figures.	Produce composites of figures.	Revise configurations of figures.	To elaborate on a given object or figure.
o a-	Group symbols in different ways.	Relate symbols in different ways.	Organize symbols into systematic arrangements.	Revise symbols in different ways.	Produce alternative symbols suggested by stimuli.
ary te a-	Produce categories of ideas.	Produce relationships between ideas.	Organize words to describe complex ideas.	Produce verbal responses involving reinterpretation of an object or situation.	Produce several ideas suggested by an object.
ary le	Produce categories of behavior.	Generate relations between given behaviors.	Organize behaviors into meaningful systems.	Revise behaviors in different ways.	Suggest outcomes of behavior.

(Return to Brainstorming as Soon as Practical)

gist,

9.13 Summary of Transformation Activities (Kindergarten through Adult)

Figural (A collection of objects which can be assembled in a variety of ways)--Students are instructed to assemble the objects in different or unusual ways or to invent new uses for the objects.

Symbolic (A page with directions, examples and given words is provided--9.13a or 9.13b)--The students are asked to assemble lists of words in which each word is identical with the previous word in the list except that one letter is altered (a letter added, a letter omitted or a letter substituted). Emphasis should be on length of list (no words repeated) or longest word generated. The words must be real words.

Semantic (A piece of paper which emits an odor)--The students are asked to record in writing (verbally in lower grades) the unusual impression or feeling which results from encountering the odor.

Behavioral (A variety of unusual hats)--Students are asked to describe their feelings about a person as a result of his wearing a specific hat.

6.0 Description of Structure-of-Intellect* (Overhead Projection Presentation) [Time est. 20 min.]

6.1 The Guilford or Structure-of-Intellect model is a well-documented and well-researched attempt to identify and organize thinking abilities.

6.2 The model contains three dimensions.

6.3 One dimension of the model concerns the type of information to be processed. This dimension is called "contents" (the type of information)--Overlay #1 (6.3).

The contents portion of the model contains Figural, Symbolic, Semantic and Behavioral dimensions.

6.4 The second dimension of the model concerns the intellectual activities or processes. This dimension is called "operations" (intellectaul processes)--Overlay #2 (6.4).

The operations portion of the model contains cognition (recognition), memory, divergent production, convergent production and evaluation.

6.5 The third dimension of the model concerns the forms information takes once it is processed. This dimension is called "products" (the form of processed information)--Overlay #3 (6.5).

The products portion of the model contains units, classes, relations, systems, transformations and implications.

6.6 The three dimensions of contents (type of information), operations (intellectual processes) and products (the form of the processed information) generate 120 different aspects of intellect or thinking ability.

6.7 The divergent thinking portion of the model was used as a theoretical base for this program--Overlay #4 (6.7).

The divergent transformation activities (junk box, word chains, odor paper, hats) were developed for this section of the model. Overlay #4 (6.7)

← (Divergent Thinking Section of SOI, handout)

*For additional information, see J. P. Guilford, 1959; J. P. Guilford, 1967; J. P. Guilford, 1968; J. P. Guilford and R. Hoepfner, 1971.

8.4 Guidelines for Identifying Hypotheses

A. Hypothesis defined: A hypothesis is a divergent-type idea statement which posits a plausible solution (complete or partial) for a given problem. Such statements either make explicit or imply an if-then relation, such as: "If such-and-such, Then the problem will be solved (completely or in part)."*

B. Goal and exclusions: The goal is to identify original hypotheses (solutions) posited by pupils. Hypotheses which are highly conventional or commonly known (or accepted) solutions should not be counted. Hypotheses which are merely repeats of solutions that the pupils have heard others offer should not be counted. (This, of course, is a matter of judgment on the part of the observer).

C. Inclusions: A divergent-type idea statement should be counted as a hypothesis under any of the following circumstances:

1. If it posits a complete solution to the problem under consideration.

2. If it posits a single element (or part) of the solution to the problem under consideration.

3. If it posits several elements (or parts) of the solution to the problem under consideration.

4. If it consists of adding a new element to a hypothesis already given.

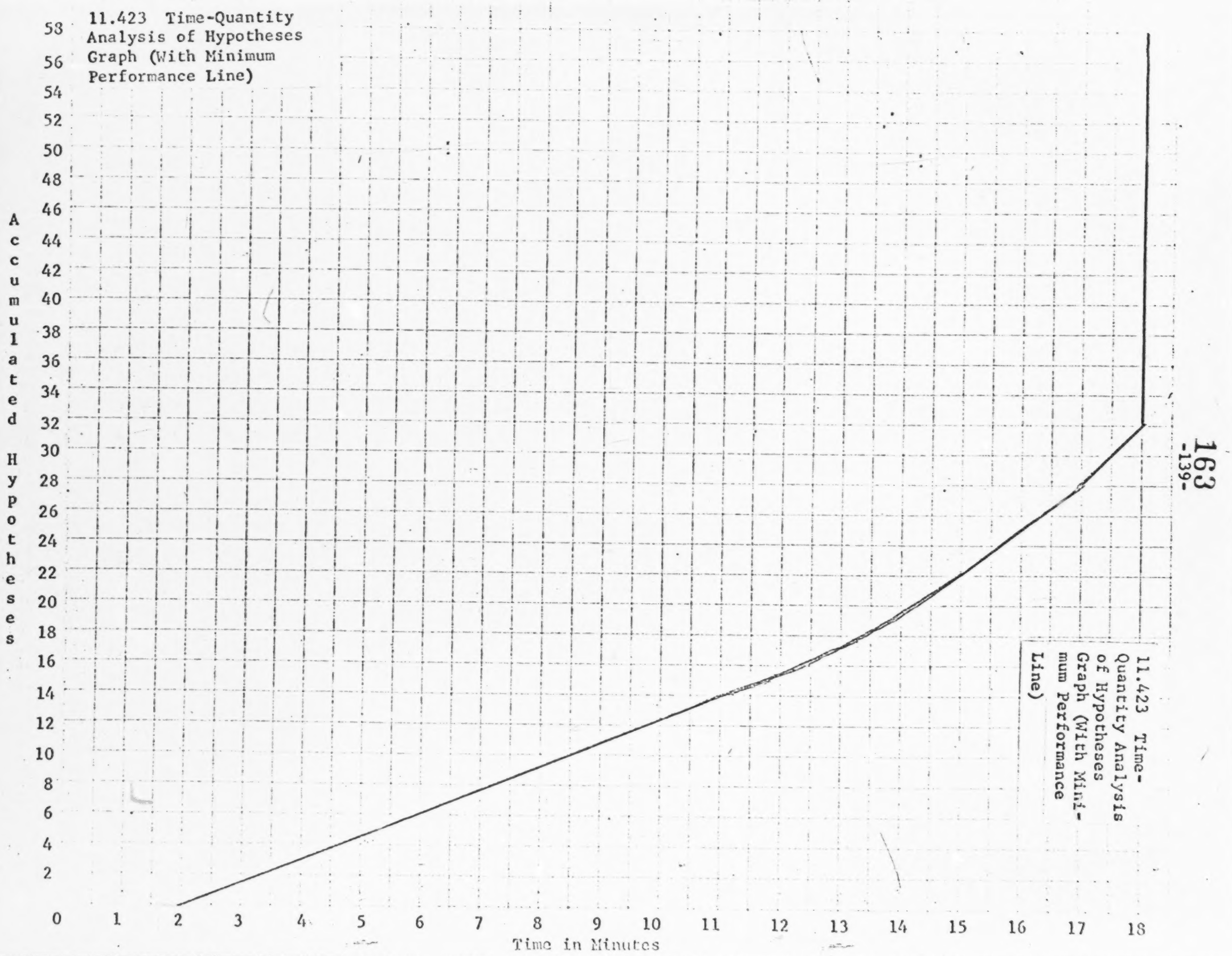
5. If it consists of adding several new elements to a hypothesis already given.

D. Hypotheses and the DOM: All of the cells of the Divergent Operations Matrix (DOM) are probably related to the generation of plausible hypotheses. However, discussions of causes, consequences, relationships, predictions, or particular elements of the problem are not hypotheses per se. Only when divergent-type ideas brought up in such discussions are stated as possible solutions to the problem under consideration are they to be considered hypotheses.

E. Summary: THUS, FOR THE PURPOSES OF THIS TRAINING PROGRAM, DIVERGENT-TYPE IDEA RESPONSES OF PUPILS ARE TO BE COUNTED AS HYPOTHESES ONLY WHEN THEY CONFORM TO THE VARIOUS SPECIFICATIONS ENUMERATED IN A, B, C, AND D ABOVE!

*Definition of Divergent Production: Generation of information from given information, where the emphasis is upon variety and quantity of output from the same source; a search for logical alternatives (Guilford, 1969).

11.423 Time-Quantity Analysis of Hypotheses Graph (With Minimum Performance Line)



11.423 Time-Quantity Analysis of Hypotheses Graph (With Minimum Performance Line)